Unit-2
Physical Layer and Media

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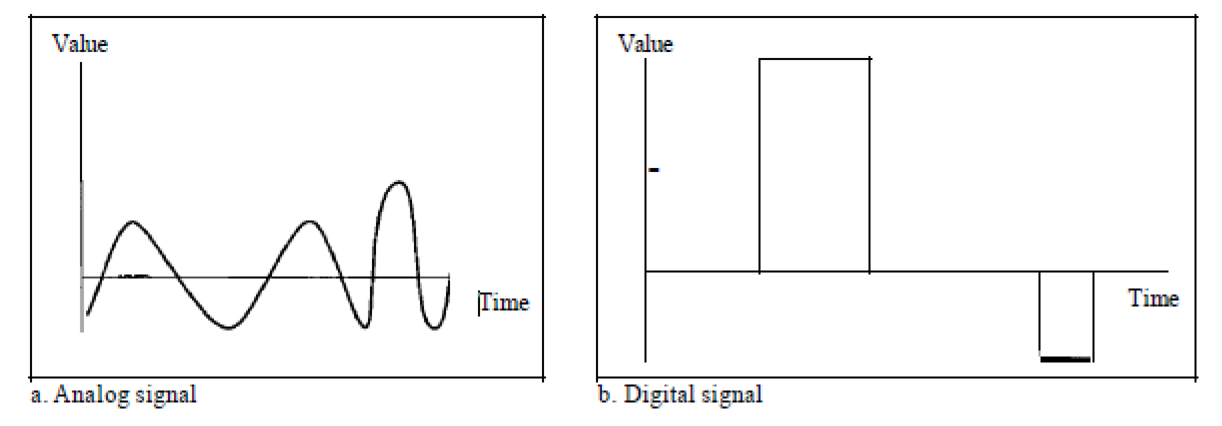
Analog and Digital

- Analog and Digital Data
  - Data can be analog or digital.
  - The term analog data refers to information that is continuous digital data refers to information that has discrete states.
  - Analog data, such as the sounds made by a human voice, take on continuous values
  - Digital data take on discrete values. For example, data are stored in computer memory in the form of 0s and 1s.

Analog and Digital

- Analog and Digital signal
  - An analog signal has infinitely many levels of intensity over a period of time. As the wave moves from value *A* to value *B,* it passes through and includes an infinite number of values along its path.
  - A digital signal, on the other hand, can have only a limited number of defined values. Although each value can be any number, it is often as simple as 1 and 0.

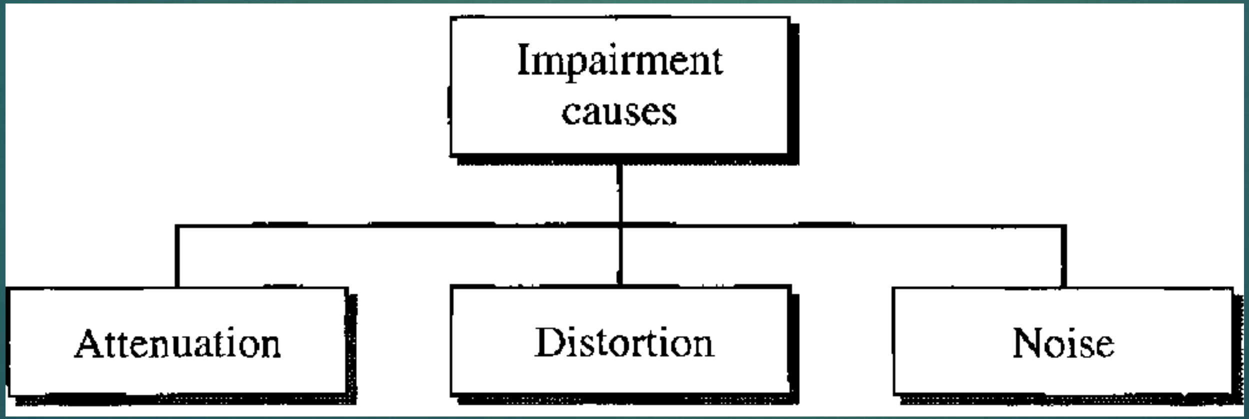


Periodic and Non-periodic signals

- Both analog and digital signals can take one of two forms: periodic or nonperiodic(aperiodic).
- A periodic signal completes a pattern within a measurable time frame, called a period, and repeats that pattern over subsequent identical periods. The completion of one full pattern is called a cycle.
- A nonperiodic signal changes without exhibiting a pattern or cycle that repeats over time.
- In data communications, we commonly use periodic analog signals and nonperiodic digital signals.

Transmission Impairment

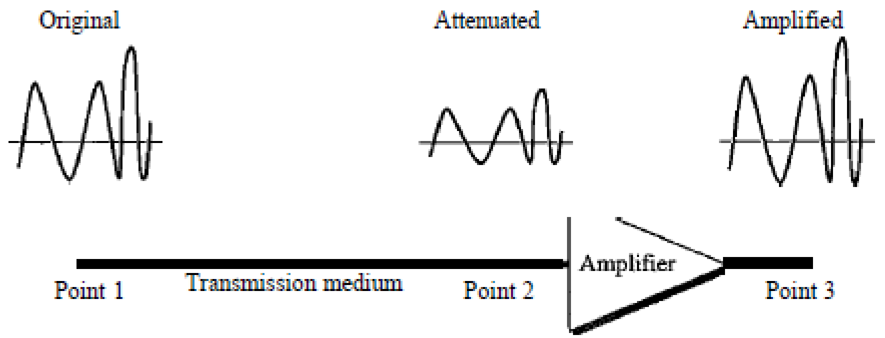
- Signals travel through transmission media, which are not perfect. The imperfection causes signal impairment(the signal at the beginning of the medium is not the same as the signal at the end of the medium).
- Three causes of impairment are attenuation, distortion, and noise.



Attenuation

- Attenuation means a loss of energy.
- When a signal, simple or composite, travels through a medium, it loses some of its energy in overcoming the resistance of the medium.
- That is why a wire carrying electric signals gets warm, if not hot, after a while. Some of the electrical energy in the signal is converted to heat.

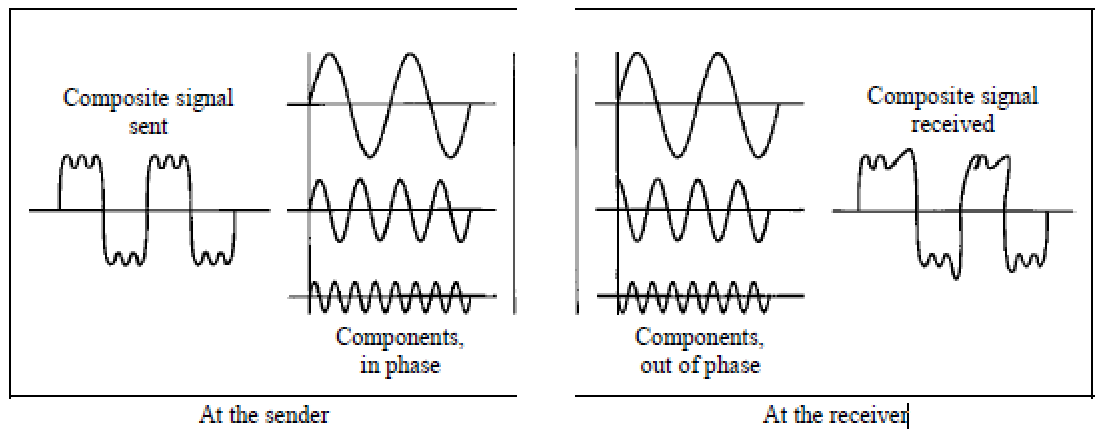
Figure 3.26 *Attenuation*



Distortion

- Distortion means that the signal changes its form or shape.
- Distortion can occur in a composite signal made of different frequencies. Each signal component has its own propagation speed through a medium and, therefore, its own delay in arriving at the final destination.
- Differences in delay may create a difference in phase if the delay is not exactly the same as the period duration.

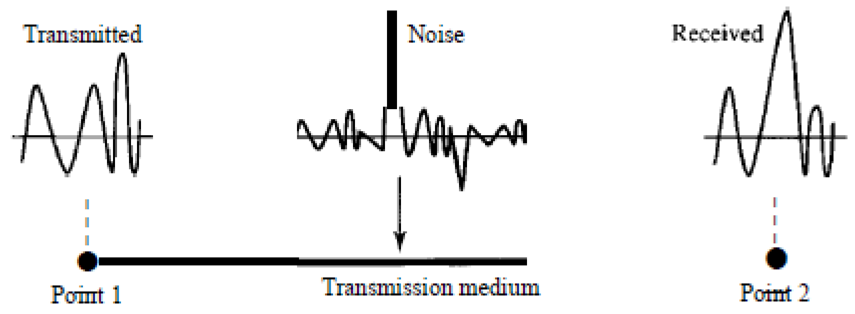
Figure 3.28 *Distortion*



Noise

- Noise is any unwanted or interfering signal that affects the quality and reliability of digital communication systems. It can originate from various sources, both internal and external, and can have different effects on the transmitted or received data.
- Several types of noise, such as thermal noise, induced noise, crosstalk, and impulse noise, may corrupt the signal.

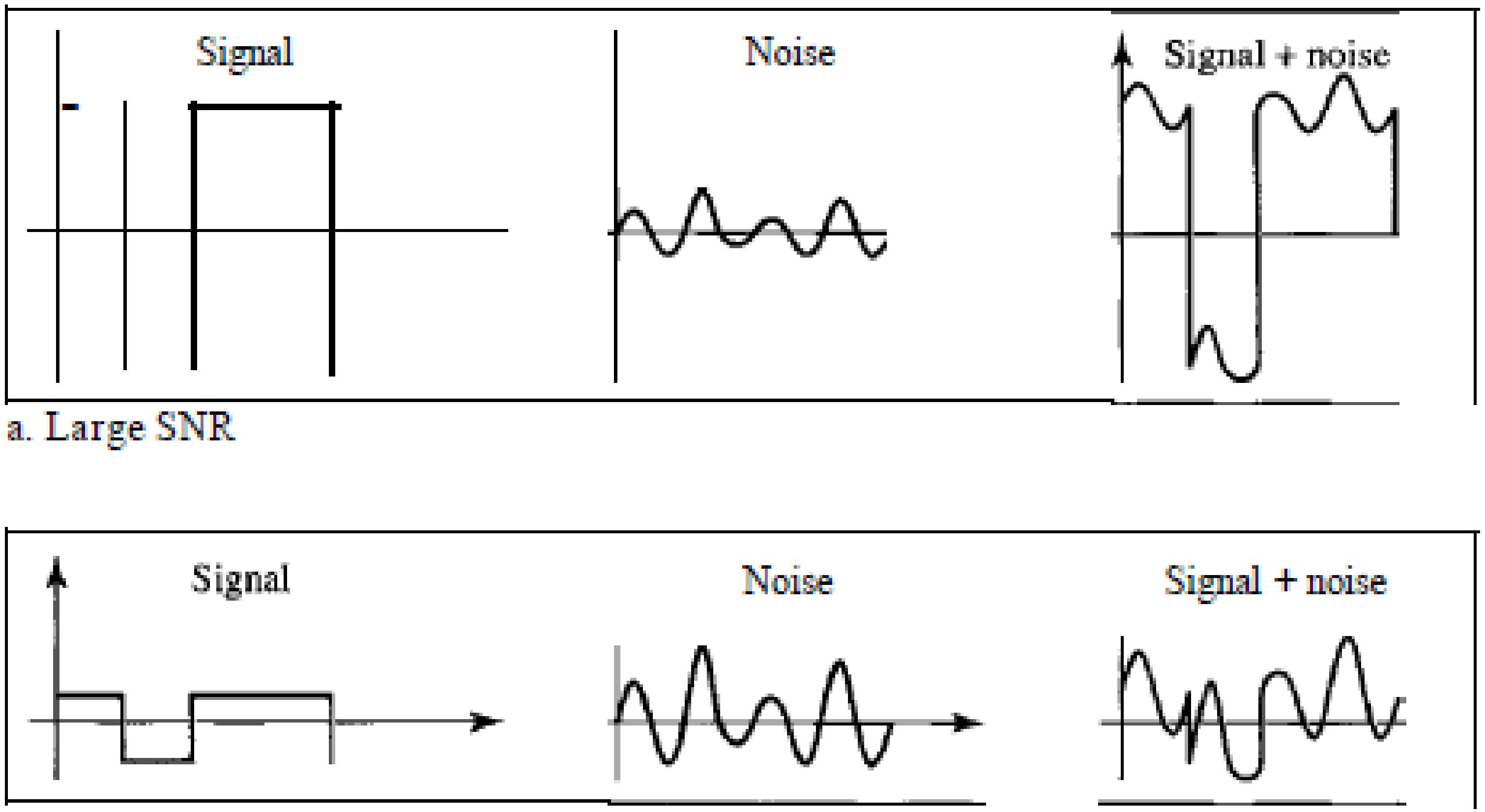
Figure 3.29 *Noise*



Signal to Noise Ratio(SNR)

- SNR is actually the ratio of what is wanted (signal) to what is not wanted (noise).
- A high SNR means the signal is less corrupted by noise; a low SNR means the signal is more corrupted by noise.
- Mathematically,
- We need to consider the average signal power and the average noise power because these may change with time
- Because SNR is the ratio of two powers, it is often described in decibel units, , defined as

SNR



a. Large SNR

b. Small SNR

Numerical

- The power of a signal is 10 mW and the power of the noise is 1 μW; what are the values of SNR and ?

Solution: Given, Average signal Power=10mW=10×

Average Noise Power=1

The values of SNR and can be calculated as follows:

SNR =

SNR = =10000

=

=40

Data rate limits

- A very important consideration in data communications is how fast we can send data, in bits per second. over a channel. Data rate depends on three factors:
  - The bandwidth available
  - The level of the signals we use
  - The quality of the channel (the level of noise)
- Two theoretical formulas were developed to calculate the data rate:
  - Nyquist for a noiseless channel
  - Shannon for a noisy channel.

Noiseless channel: Nyquist Bit rate

- For a noiseless channel, the Nyquist bit rate formula defines the theoretical maximum bit rate

BitRate = 2 x bandwidth x

where, bandwidth is the bandwidth of the channel,

L is the number of signal levels used to represent data

BitRate is the bit rate in bits per second.

Note: Numerical already done in class

Noisy Channel: Shannon Capacity

- We cannot have a noiseless channel; the channel is always noisy.
- In 1944, Claude Shannon introduced a formula, called the Shannon capacity, to determine the theoretical highest data rate for a noisy channel:

Capacity =bandwidth X (1 +SNR)

where, bandwidth is the bandwidth of the channel,

SNR is the signal-to-noise ratio

capacity is the capacity of the channel in bits per second.

Note: Numerical already done in class

Numerical(Something new)

Example 3.41

We have a channel with a I-MHz bandwidth. The SNR for this channel is 63. What are the appropriate bit rate and signal level?

Solution

First, we use the Shannon formula to find the upper limit.

$$C = B \log2 (1 + \text{SNR}) = 10^6 \log2 (1 + 63) = 10^6 \log_2 64 = 6 \text{ Mbps}$$

The Shannon formula gives us 6 Mbps, the upper limit. For better performance we choose something lower, 4 Mbps, for example. Then we use the Nyquist formula to find the number of signal levels.

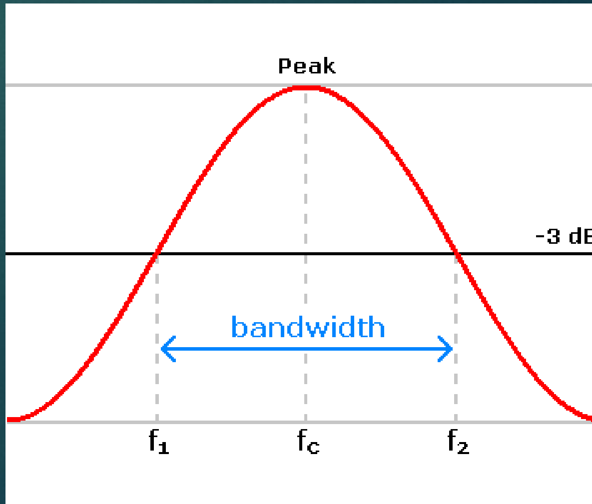
$$4\text{Mbps} = 2 \text{x } 1 \text{ MHz x } log_2 L \Rightarrow L = 4$$

Performance

- One important issue in networking is the performance of the network
- There are various factors that determines the performance of a network. Some of them are listed below:
  - Bandwidth
  - Latency
  - Throughput
  - Jitter

Bandwidth

- Bandwidth specifically refers to the capacity at which a network can transmit data.
- The term Bandwidth can be used in two different contexts with two different measuring values: bandwidth in hertz and bandwidth in bits per second.
- Bandwidth in hertz:
  - Bandwidth in hertz is the range of frequencies contained in a composite signal or the range of frequencies a channel can pass. For example, we can say the bandwidth of a subscriber telephone line is 4 kHz.
- Bandwidth in bps:
  - The term bandwidth can also refer to the number of bits per second that a channel, a link, or even a network can transmit.



Throughput

- The throughput is a measure of how fast we can actually send data through a network.
- Bandwidth in bits per second and throughput seem the same, they are different the bandwidth is a potential measurement of a link; the throughput is an actual measurement of how fast we can send data.
- For example, we may have a link with a bandwidth of 1 Mbps, but the devices connected to the end of the link may handle only 200 kbps.

Throughput(Numerical)

Example 3.44

A network with bandwidth of 10 Mbps can pass only an average of 12,000 frames per minute with each frame carrying an average of 10,000 bits. What is the throughput of this network?

Solution

We can calculate the throughput as

$$\text{Throughput} = \frac{12{,}000 \times 10{,}000}{60} = 2 \text{ Mbps}$$

The throughput is almost one-fifth of the bandwidth in this case.

Latency

- The latency or delay defines how long it takes for an entire message to completely arrive at the destination from the time the first bit is sent out from the source.
- We can say that latency is made of four components: propagation time, transmission time, queuing time and processing delay.

Latency =propagation time +transmission time +queuing time + processing delay

- Propagation time
  - Propagation time measures the time required for a bit to travel from the source to the destination.
  - The propagation time is calculated by dividing the distance by the propagation speed.

Latency

- Numerical

Example 3.45

What is the propagation time if the distance between the two points is 12,000 km? Assume the propagation speed to be 2.4×10^8 mls in cable.

Solution

We can calculate the propagation time as

$$\text{Propagation time} = \frac{12{,}000 \times 1000}{2.4 \times 10^8} = 50 \text{ ms}$$

Latency

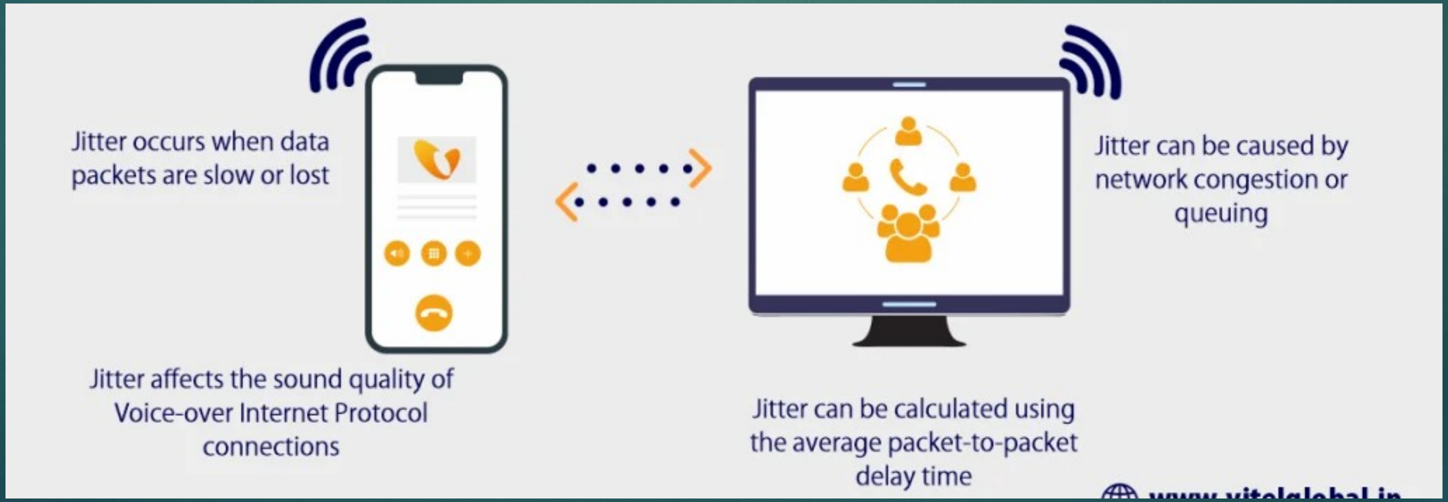
- Transmission Time
  - The time between the transmission of first bit by the sender and the arrival of last bit at the destination is known as transmission time.
  - Time between the first bit leaving the sender and the last bit arriving at the receiver. The first bit leaves earlier and arrives earlier; the last bit leaves later and arrives later.
  - The time required for transmission of a message depends on the size of the message and the bandwidth of the channel.

Latency

- Queuing time
  - The third component in latency is the queuing time, the time needed for each intermediate or end device to hold the message before it can be processed.
  - The queuing time is not a fixed factor; it changes with the load imposed on the network. When there is heavy traffic on the network, the queuing time increases
- Propagation delay
  - Propagation delay is the amount of time required for a signal to be received after it has been sent.
  - It is caused by the time it takes for the signal to travel through a medium.

Jitter

- Jitter is a problem if different packets of data encounter different delays and the application using the data at the receiver site is time-sensitive (audio and video data, for example).
- If the delay for the first packet is 20 ms, for the second is 45 ms, and for the third is 40 ms, then the real-time application that uses the packets endures jitter.



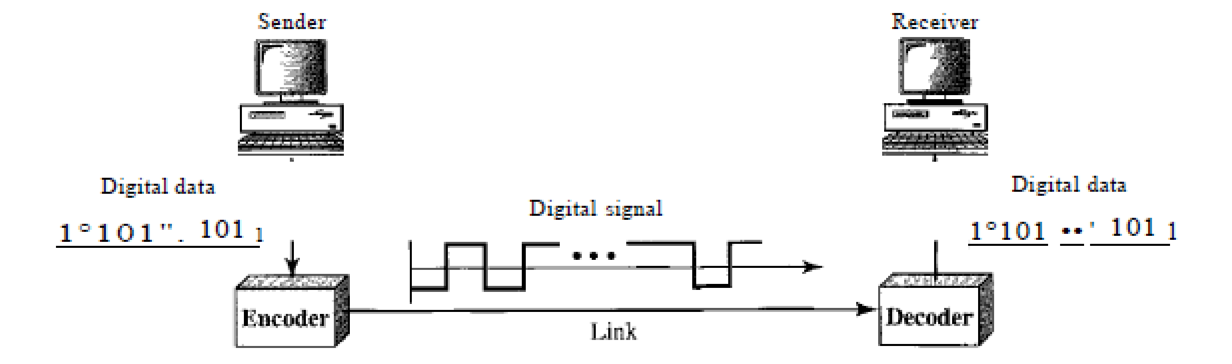
Conversion(Digital to digital)

- We can represent digital data by using digital signals.
- The conversion involves three techniques:
  - Line coding
  - Block coding
  - Scrambling

Line Coding

- Line coding is the process of converting digital data to digital signals.
- We assume that data, in the form of text, numbers, graphical images, audio, or video, are stored in computer memory as sequences of bits.
- Line coding converts a sequence of bits to a digital signal.

Figure 4.1 *Line coding and decoding*

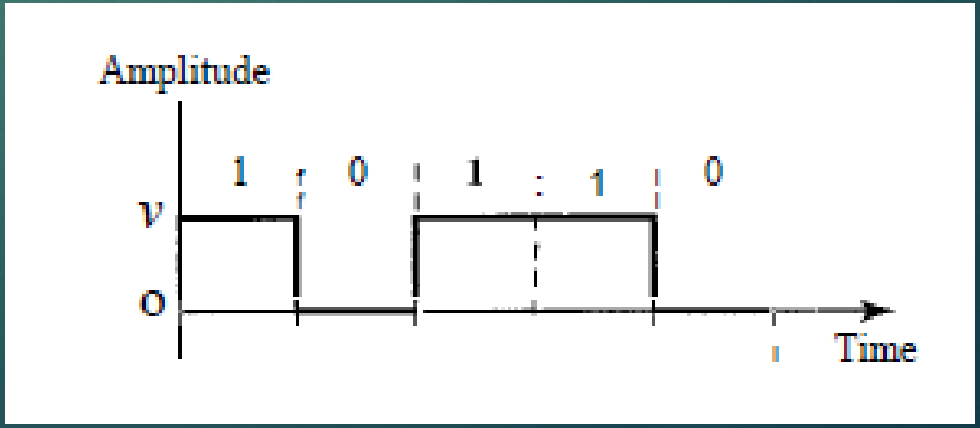


Line encoding Schemes

- We can roughly divide line encoding into five different schemes
  - Unipolar
  - Polar
  - Bipolar
  - Multilevel
  - Multitransition

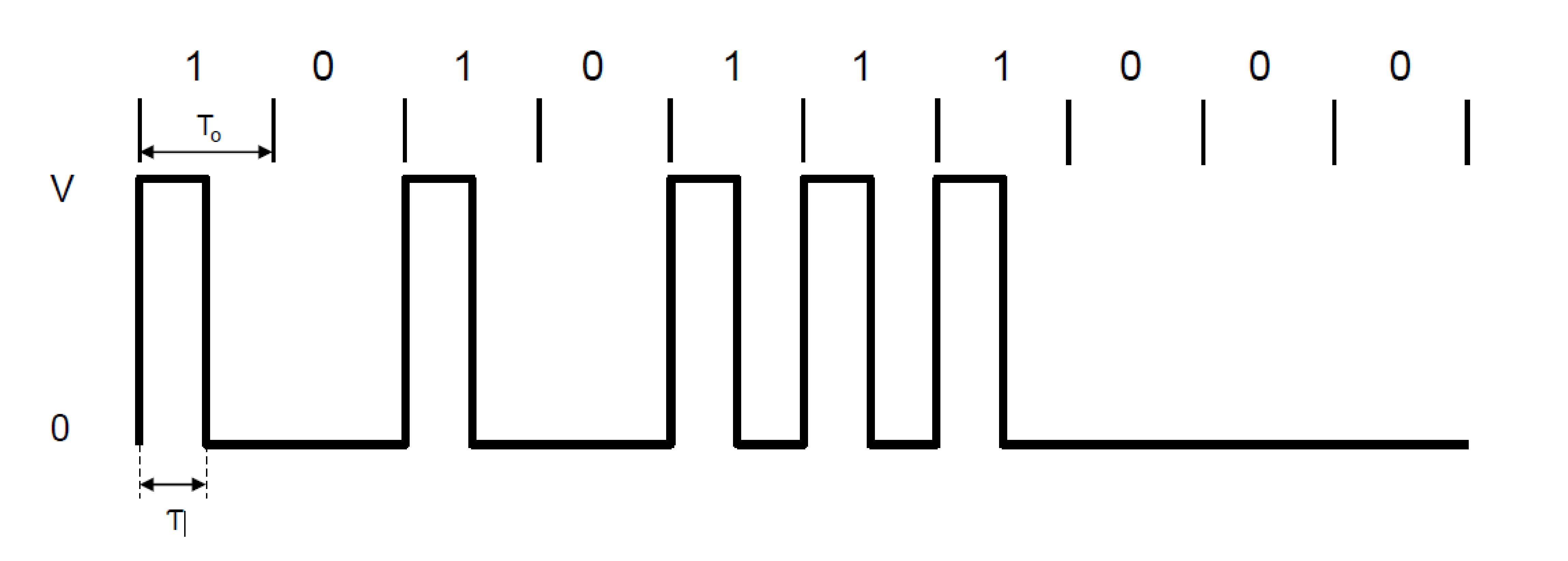
Unipolar

- In a unipolar scheme, all the signal levels are on one side of the time axis, either above or below.
- NRZ (Non-Return-to-Zero) Traditionally, a unipolar scheme was designed as a non-return-to-zero (NRZ) scheme in which the positive voltage defines bit 1 and the zero voltage defines bit 0.
- It is called NRZ because the signal does not return to zero at the middle of the bit.



Unipolar

- RZ(Return-to-Zero)

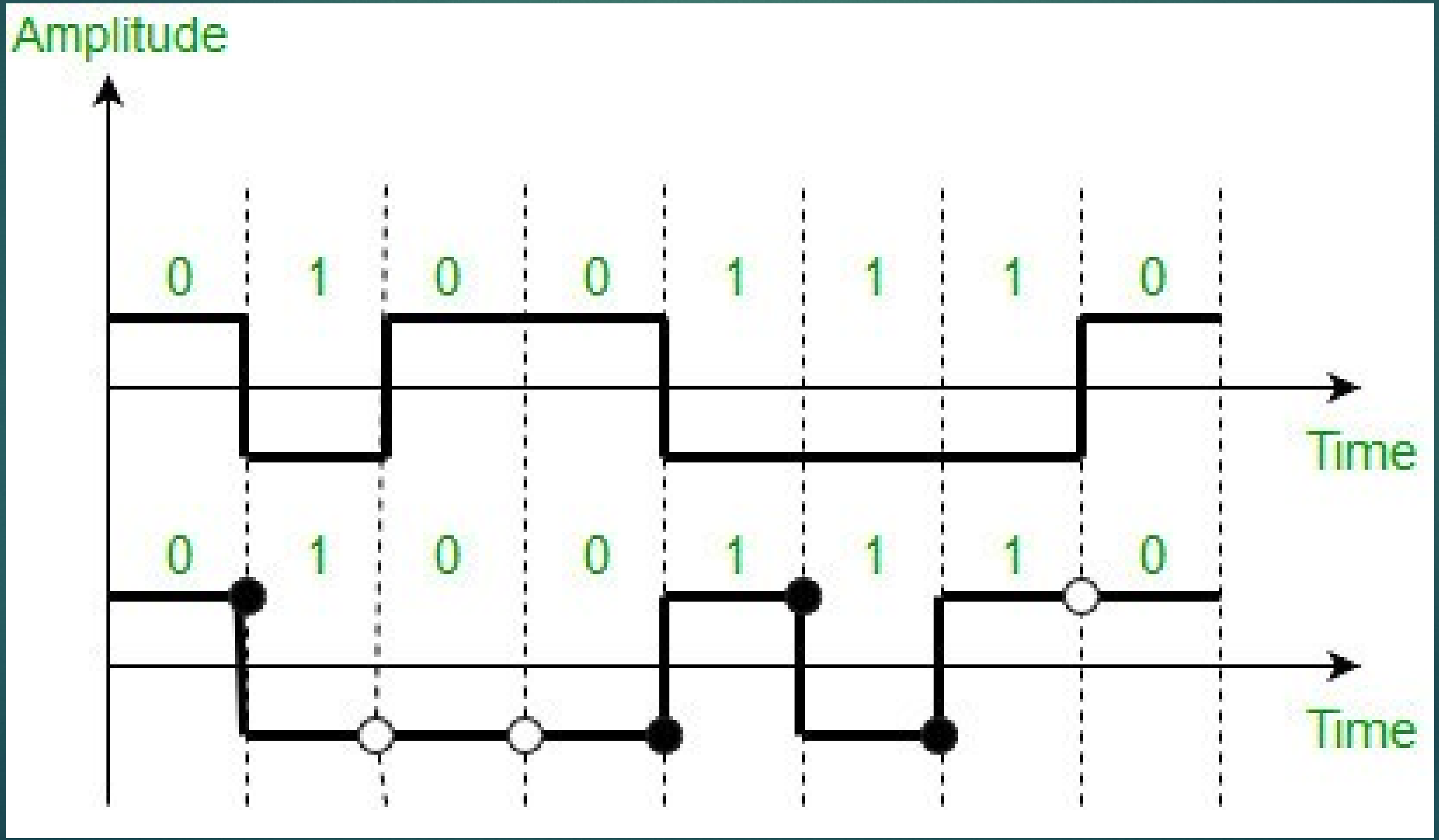


Polar

- In polar scheme, the voltages are on the both sides of the time axis. For example, the voltage level for 0 can be positive and the voltage level for 1 can be negative.
- NRZ-L(Non-Return-to-Zero): In polar NRZ encoding, we use two levels of voltage amplitude.
- We can have two versions of polar NRZ: **NRZ-L** and **NRZ-I**.
- NRZ-L (NRZ-Level), the level of the voltage determines the value of the bit. For instance in the example below negative voltage level represents binary value 1 and positive voltage level represents binary value 0.
- In the second variation, NRZ-I (NRZ-Invert), the change or lack of change in the level of the voltage determines the value of the bit. If there is no change, the bit is 0; if there is a change, the bit is 1.

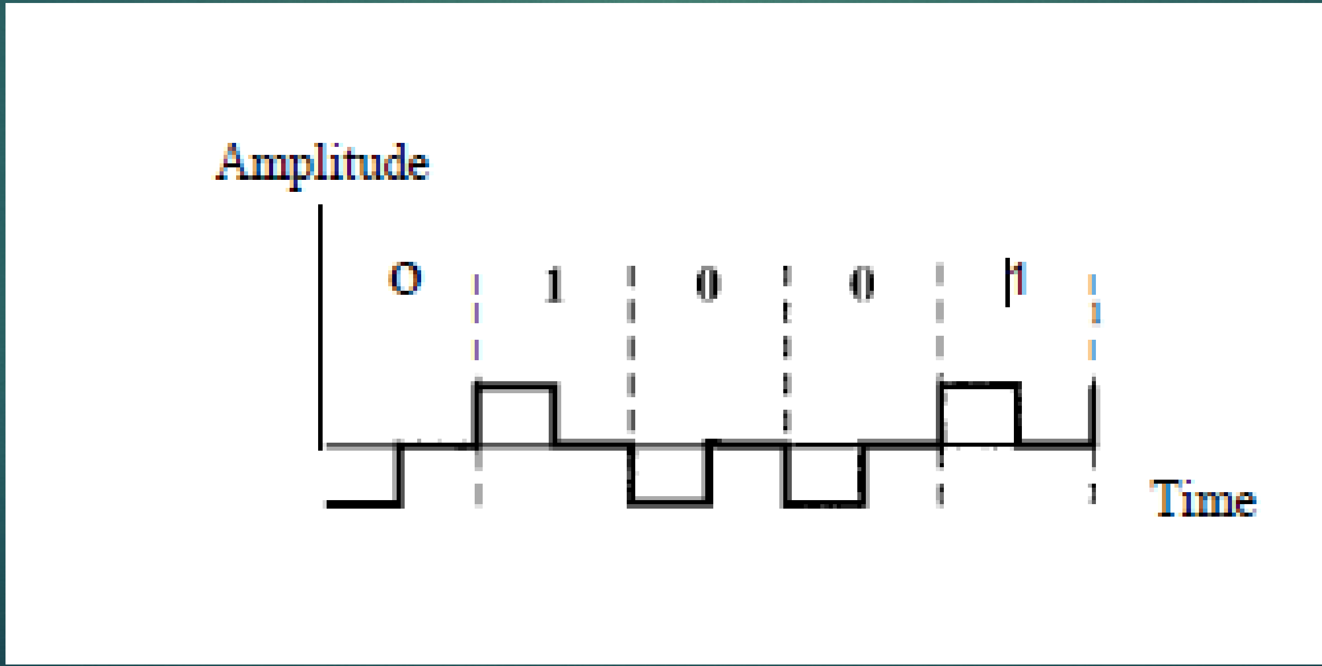
Polar

- Example: Data = 01001110.

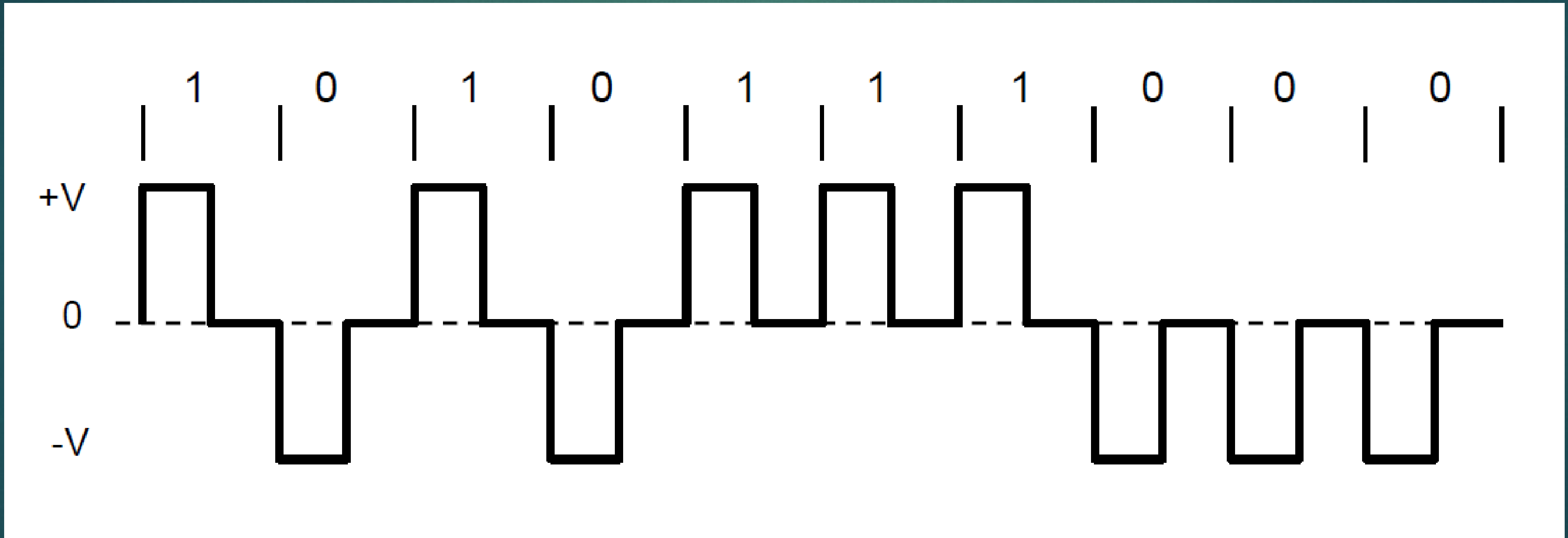


Polar

- RZ(Return-to-Zero)
- The signal changes not between bits but during the bit. In this scheme signal goes to 0 in the middle of each bit. It remains there until the beginning of the next bit.



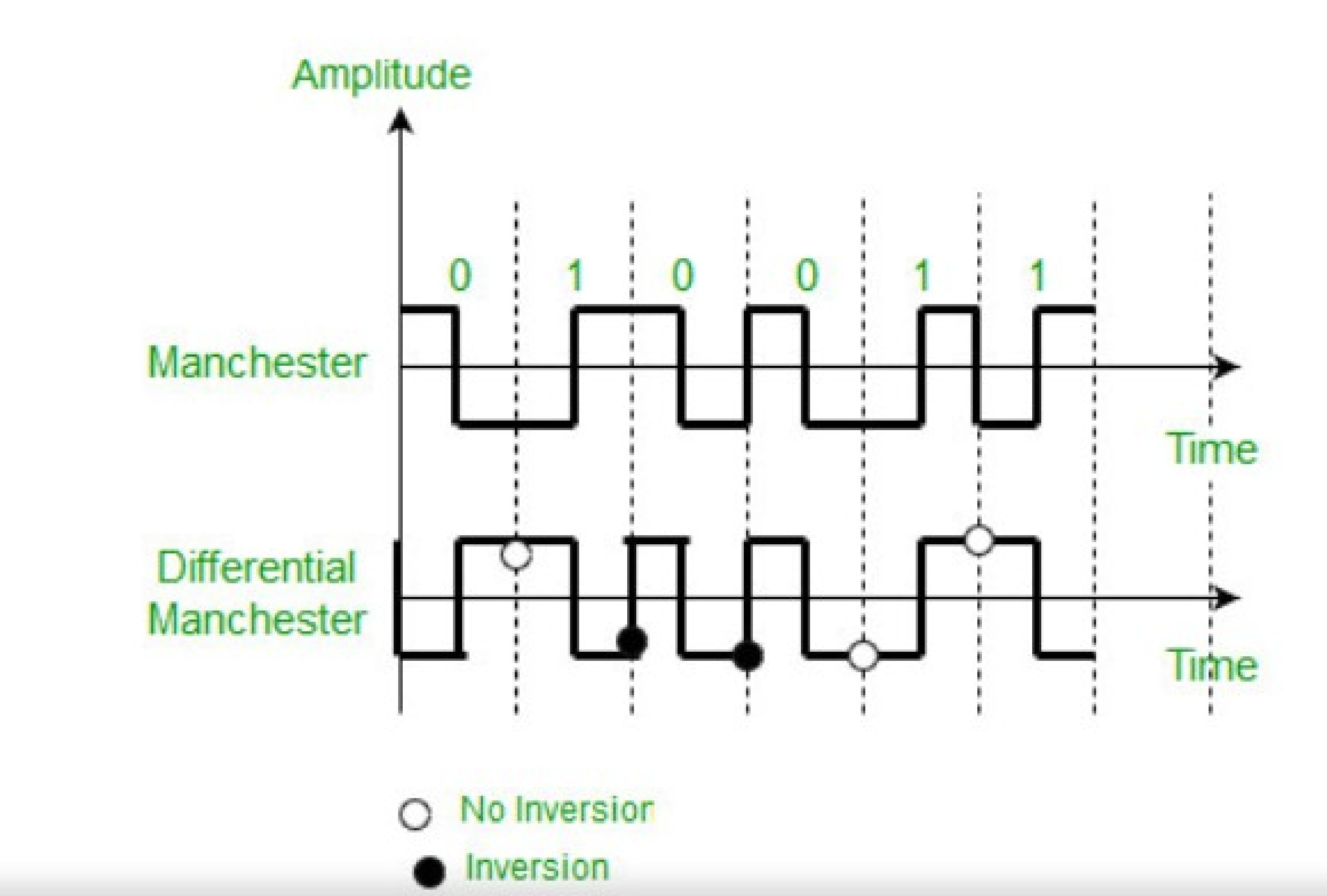
Polar (RZ)



Biphase : Manchester and Differential Manchester

- Manchester:
  - In Manchester encoding, the duration of the bit is divided into two halves.
  - The voltage remains at one level during the first half and moves to the other level in the second half.
  - The transition at the middle of the bit provides synchronization.
- Differential Manchester:
  - There is always a transition at the middle of the bit, but the bit values are determined at the beginning of the bit.
  - If the next bit is 0, there is a transition; if the next bit is 1, there is none.

Example Manchester and Differential Manchester



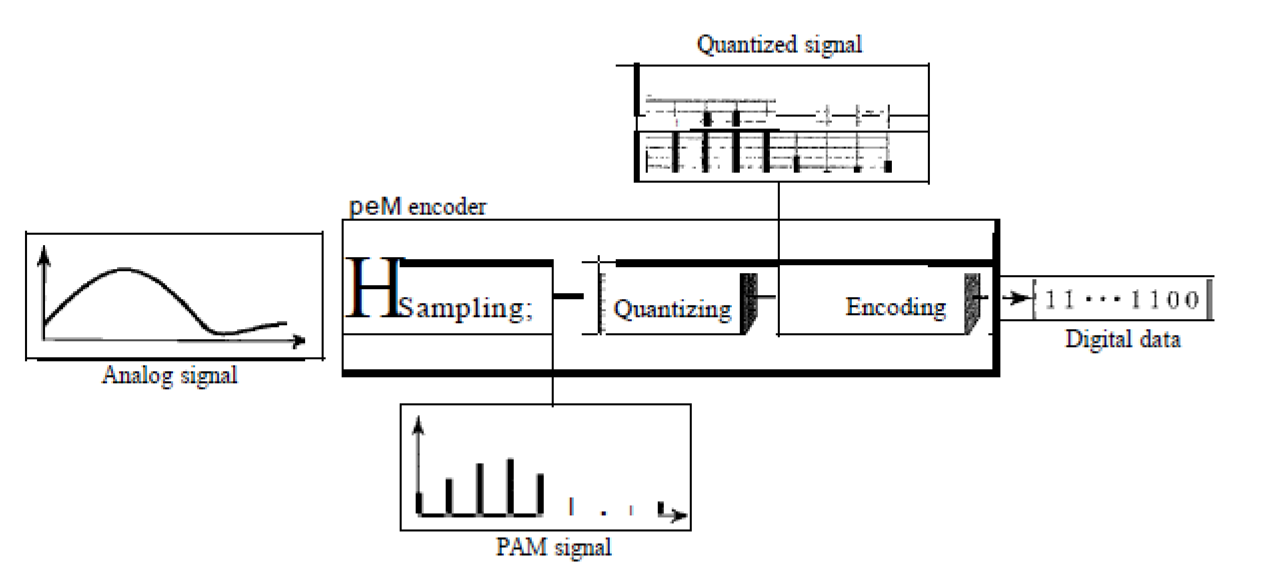
Analog-to-Digital Conversion

- Sometime it might be necessary to signal generated as analog to be converted into digital as it is today's tendency to do so.
- For example the analog signal created by a microphone must be converted into digital signal for further processing(autotune).
- There are generally two techniques to do so. They are:
  - Pulse Code Modulation(PCM)
  - Delta Modulation(DM)
- After the digital data are created (digitization), we can use one of the techniques to convert the digital data to a digital signal.

PCM

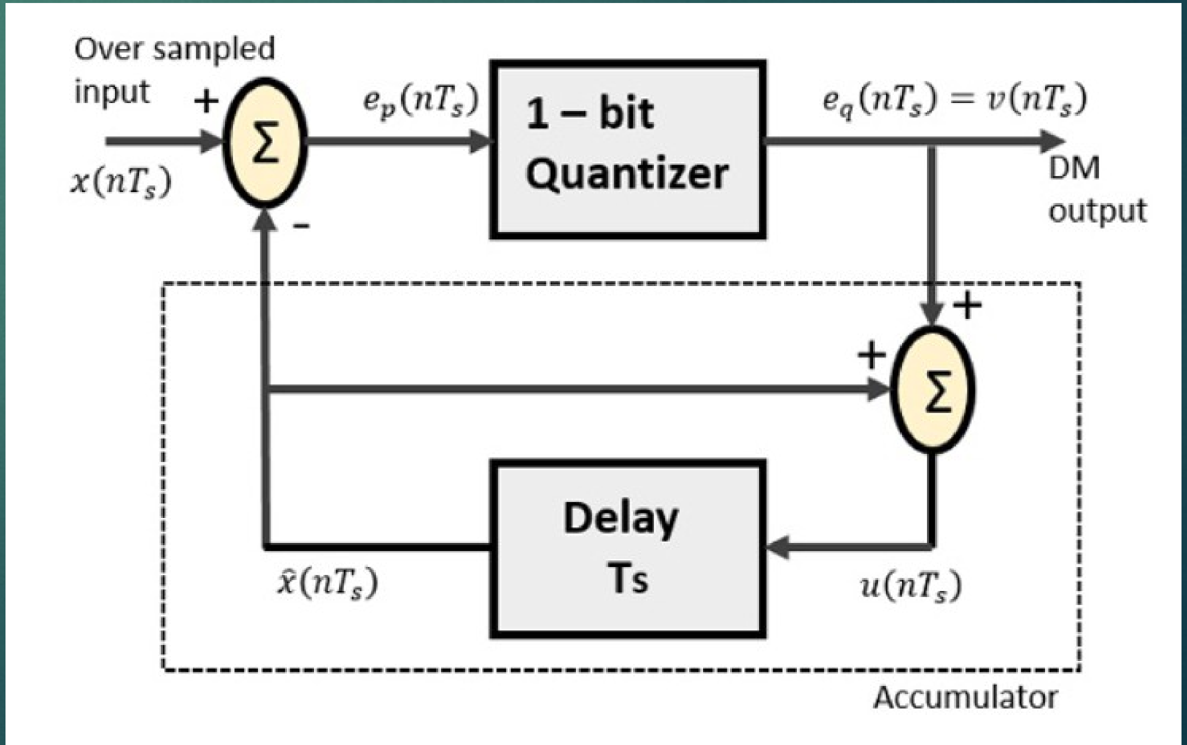
- The most common technique to change an analog signal to digital data (digitization) is called pulse code modulation (PCM). A PCM encoder has three processes that is listed below:
  - The analog signal is sampled.
  - The sampled signal is quantized.
  - The quantized values are encoded as streams of bits

Figure 4.21 *Components ofPCM encoder*

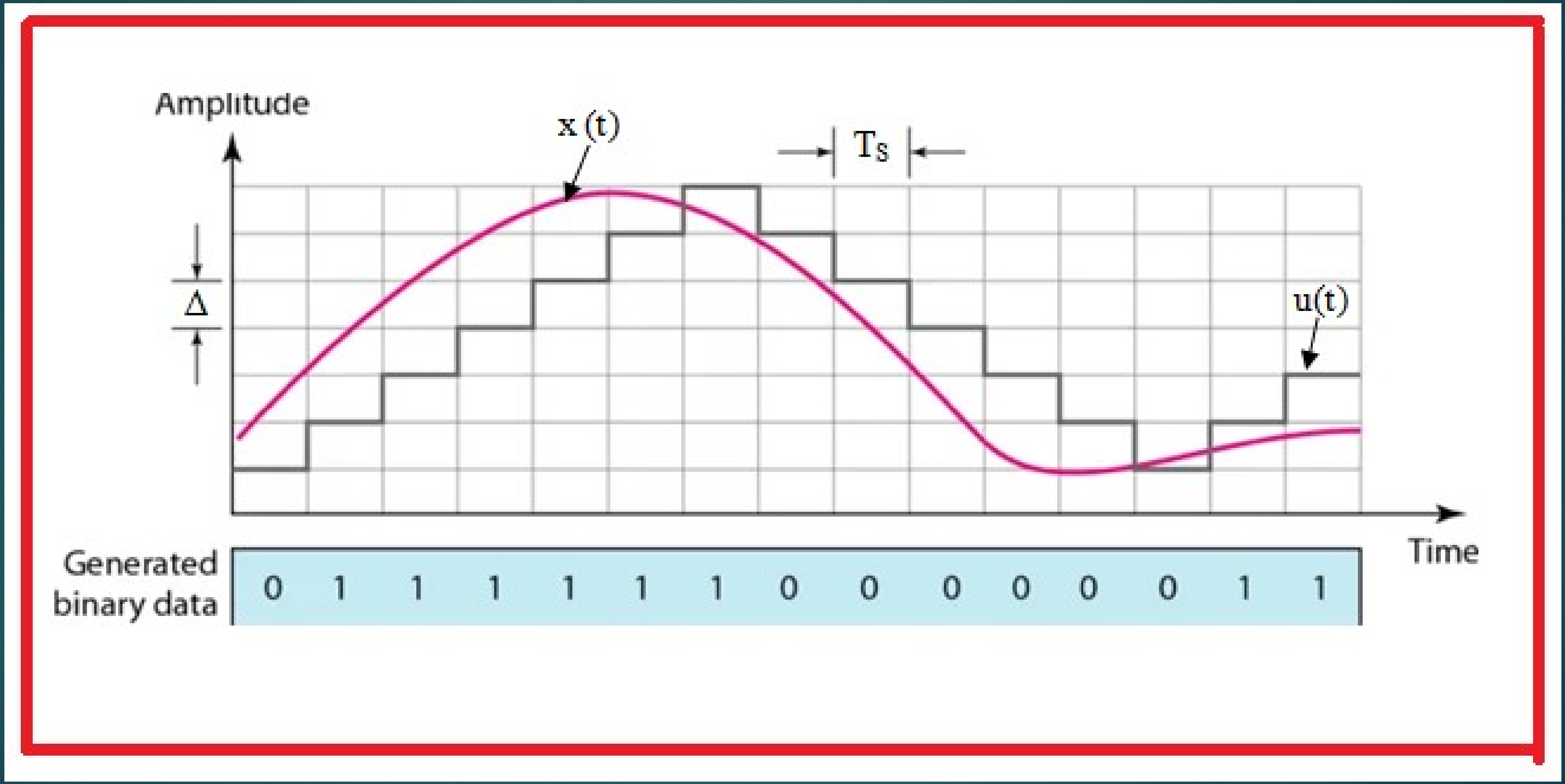


DM

- PCM is a very complex technique. Other techniques have been developed to reduce the complexity of PCM. The simplest is delta modulation.
- PCM finds the value of the signal amplitude for each sample; DM finds the change from the previous sample.



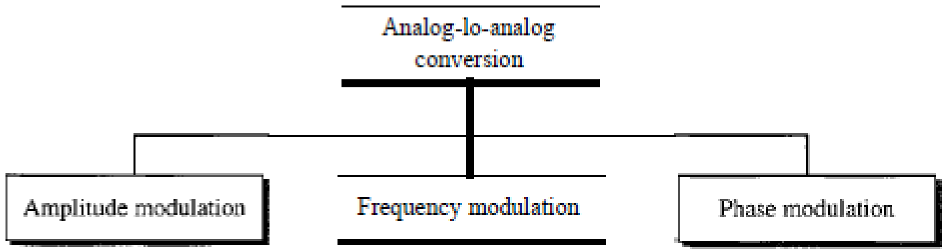
DM


Amplitude
x (t)
Ts
Δ
u(t)
Time
Generated binary data
0 1 1 1 1 1 1 0 0 0 0 0 0 1 1

Analog to Analog Conversion

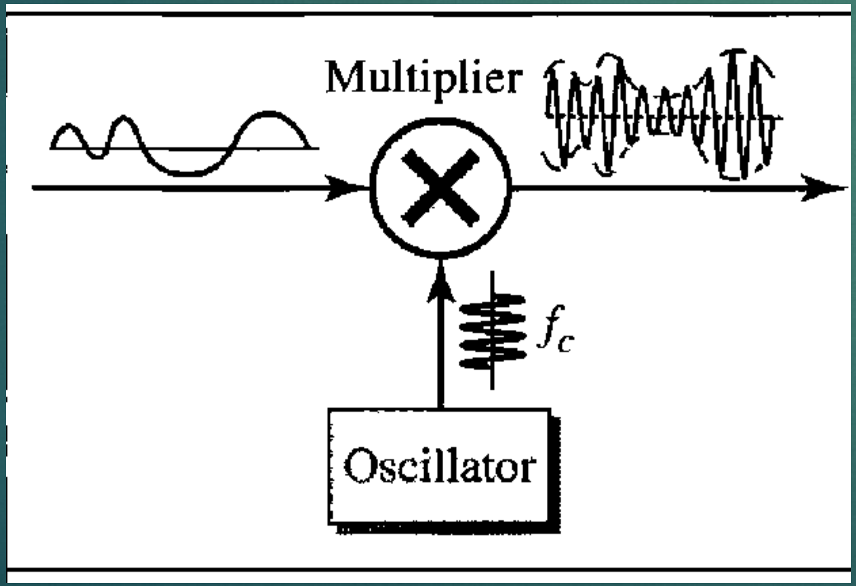
- Analog-to-analog conversion, or analog modulation, is the representation of analog information by an analog signal.

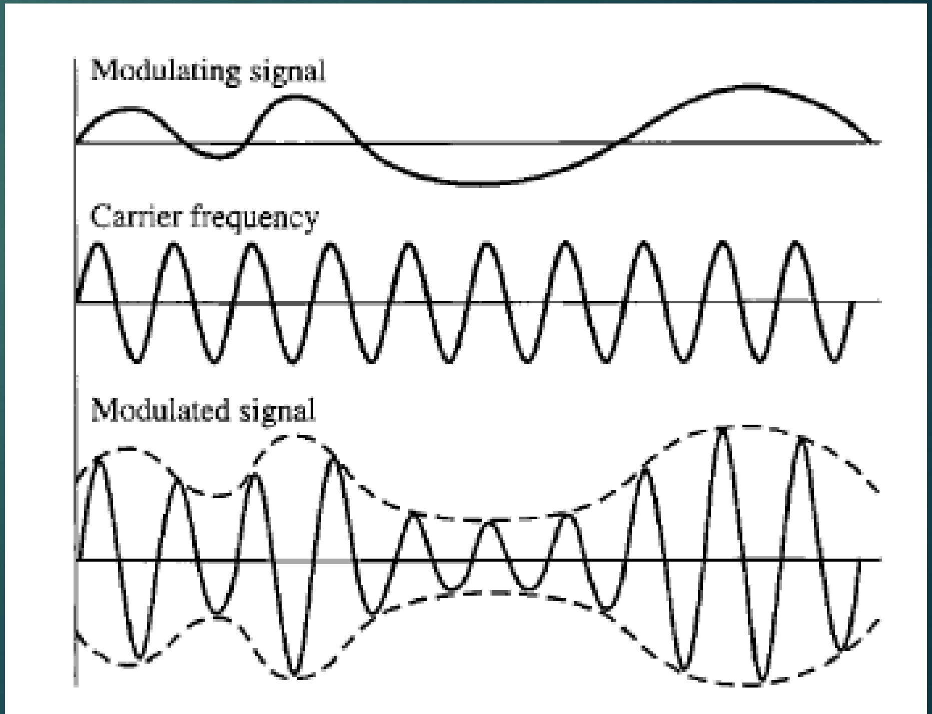
Figure 5.15 *Types ofanalog-to-analog modulation*



AM

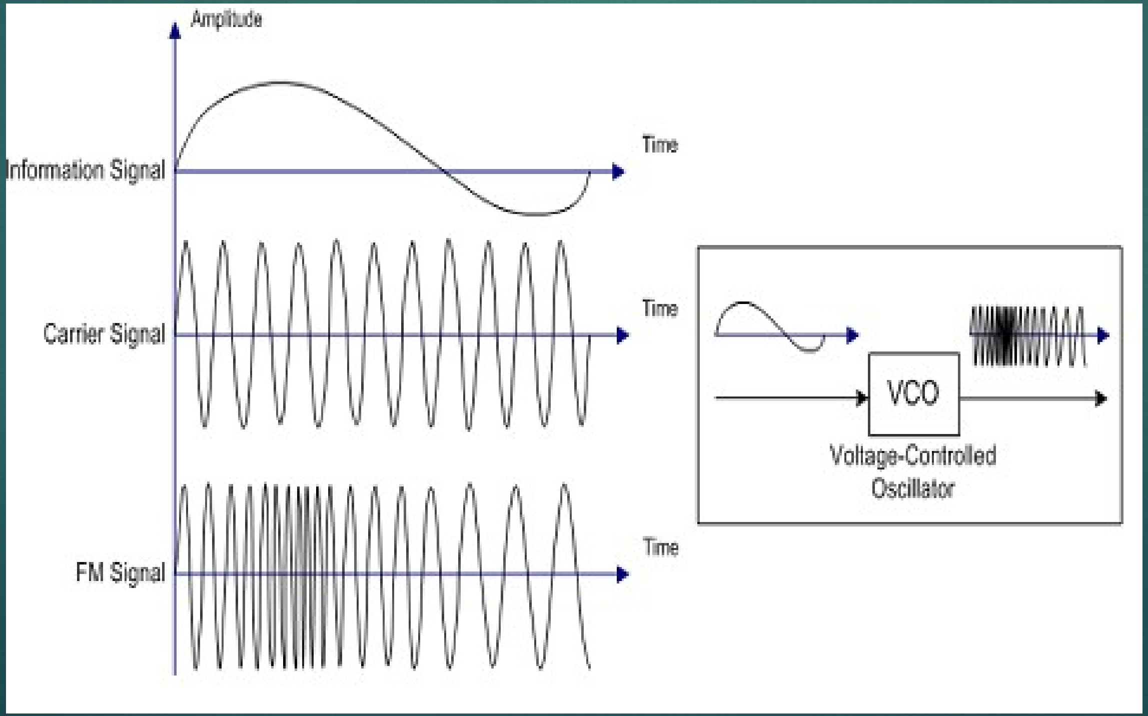
- In AM transmission, the carrier signal is modulated so that its amplitude varies with the changing amplitudes of the modulating signal. The frequency and phase of the carrier remain the same
- only the amplitude changes to follow variations in the information.





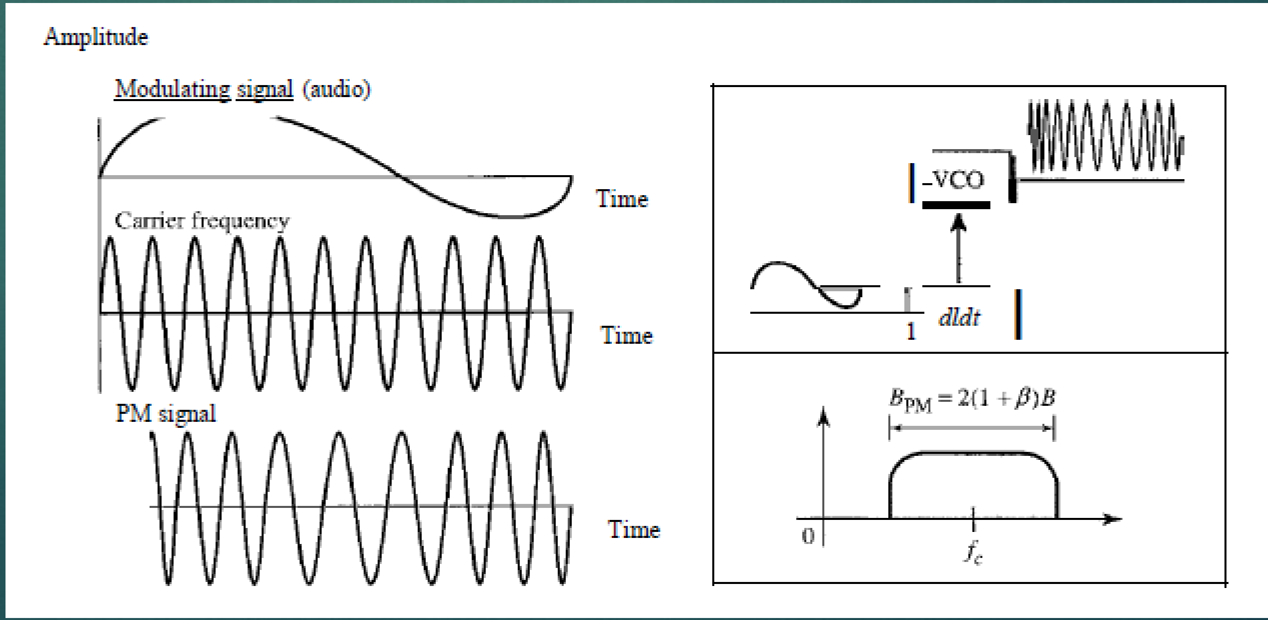
FM

- In FM transmission, the frequency of the carrier signal is modulated to follow the changing voltage level (amplitude) of the modulating signal.
- The peak amplitude and phase of the carrier signal remain constant, but as the amplitude of the information signal changes, the frequency of the carrier changes correspondingly.



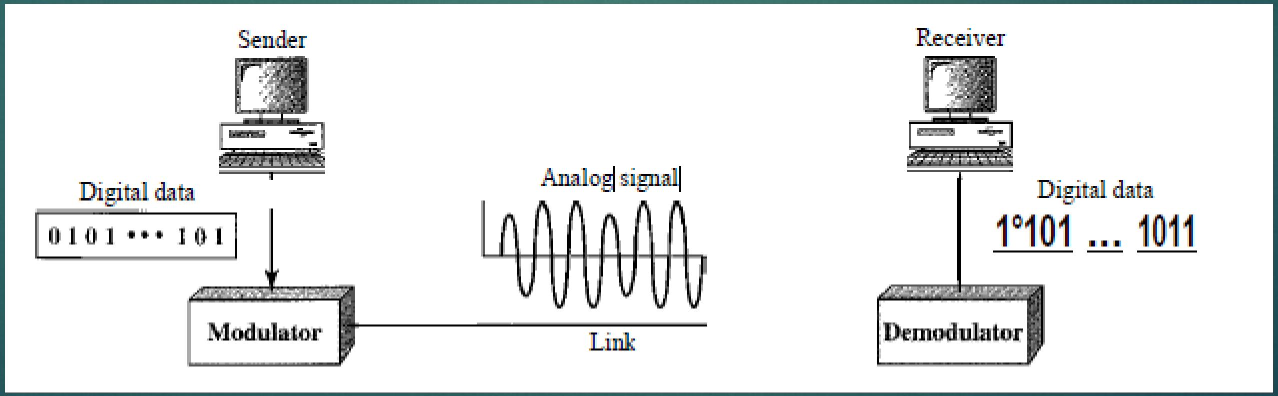
PM

- In PM transmission, the phase of the carrier signal is modulated to follow the changing voltage level (amplitude) of the modulating signal.
- The peak amplitude and frequency of the carrier signal remain constant, but as the amplitude of the information signal changes, the phase of the carrier changes correspondingly.

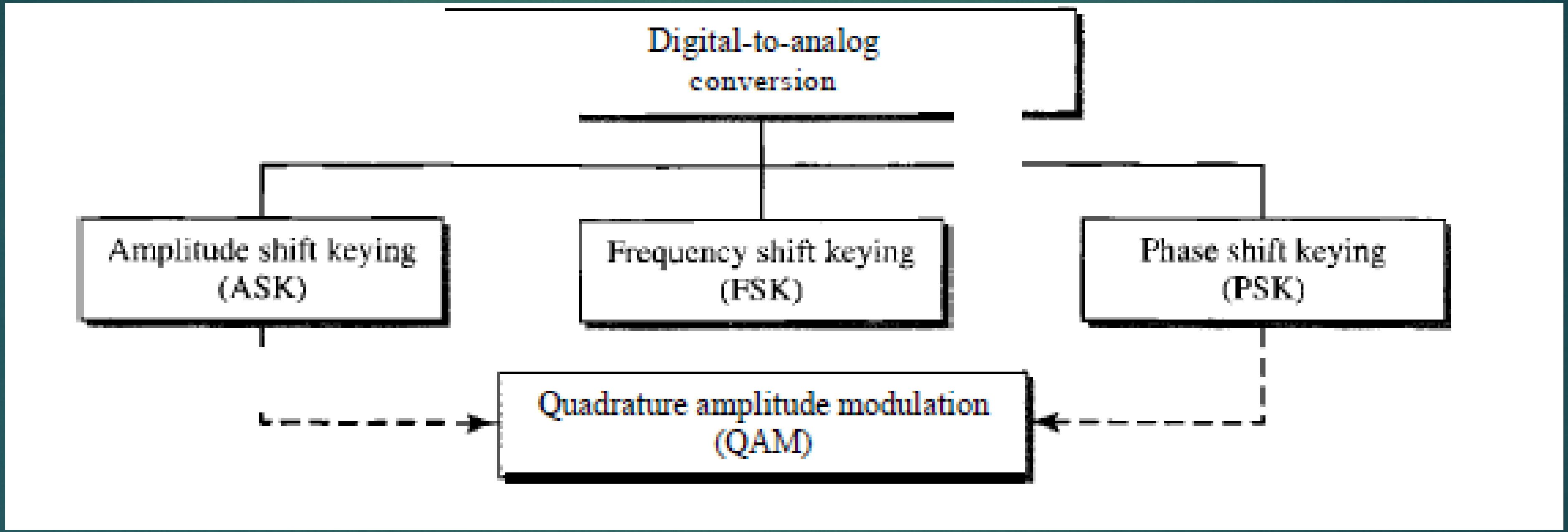


Digital to Analog Conversion

- Digital-to-analog conversion is the process of changing one of the characteristics of an analog signal based on the information in digital data.
- Figure below shows the relationship between the digital information, the digital-to-analog modulating process, and the resultant analog signal.

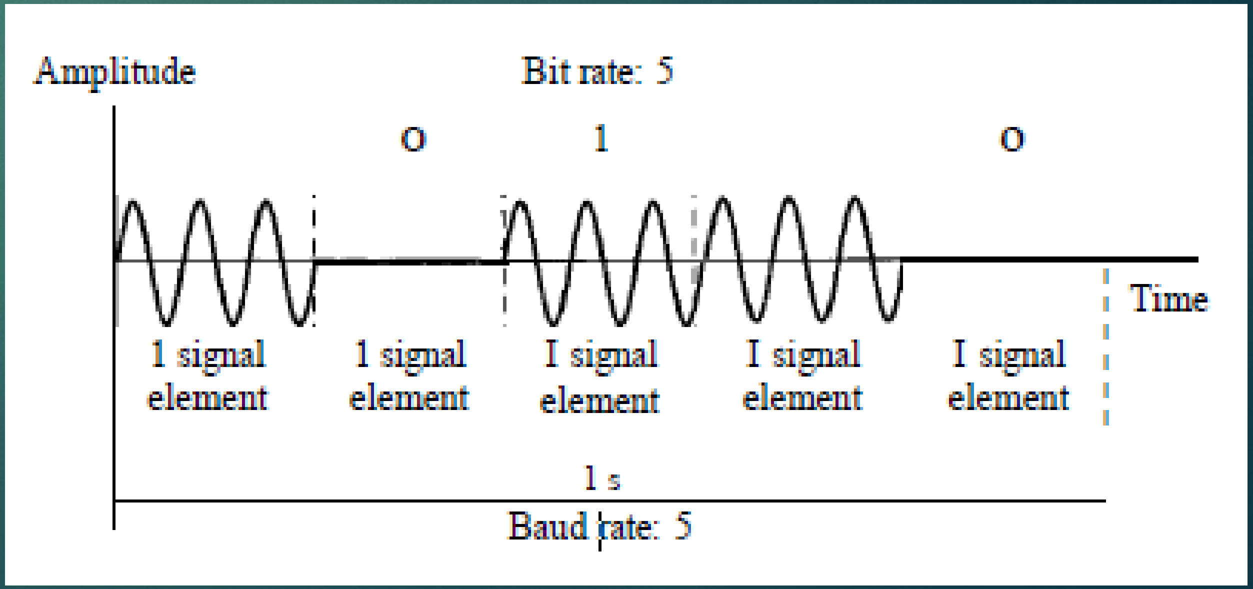


Types of digital to analog conversion



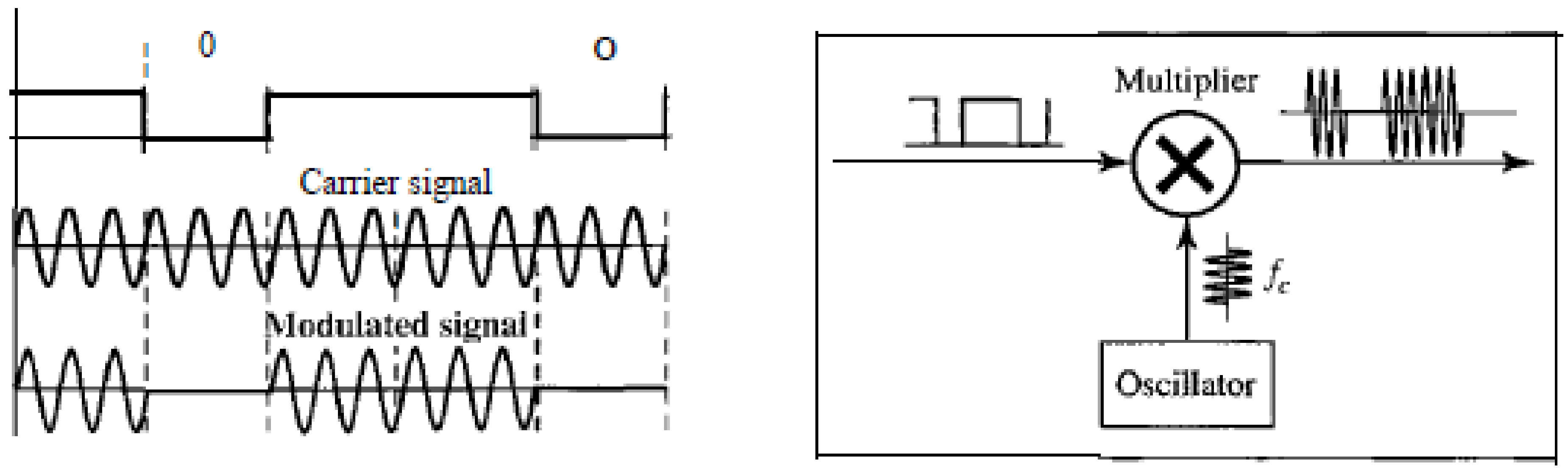
Amplitude Shift Keying(ASK)

- In amplitude shift keying, the amplitude of the carrier signal is varied to create signal elements. Both frequency and phase remain constant while the amplitude changes.
- Binary Amplitude Shift Keying(BASK):
  - We can have several levels (kinds) of signal elements, each with a different amplitude, ASK is normally implemented using only two levels.
  - This is referred to as binary amplitude shift keying or *on-off keying* (OOK). The peak amplitude of one signal level is 0; the other is the same as the amplitude of the carrier frequency.



Binary ASK

Figure 5.4 *Implementation of binary ASK*

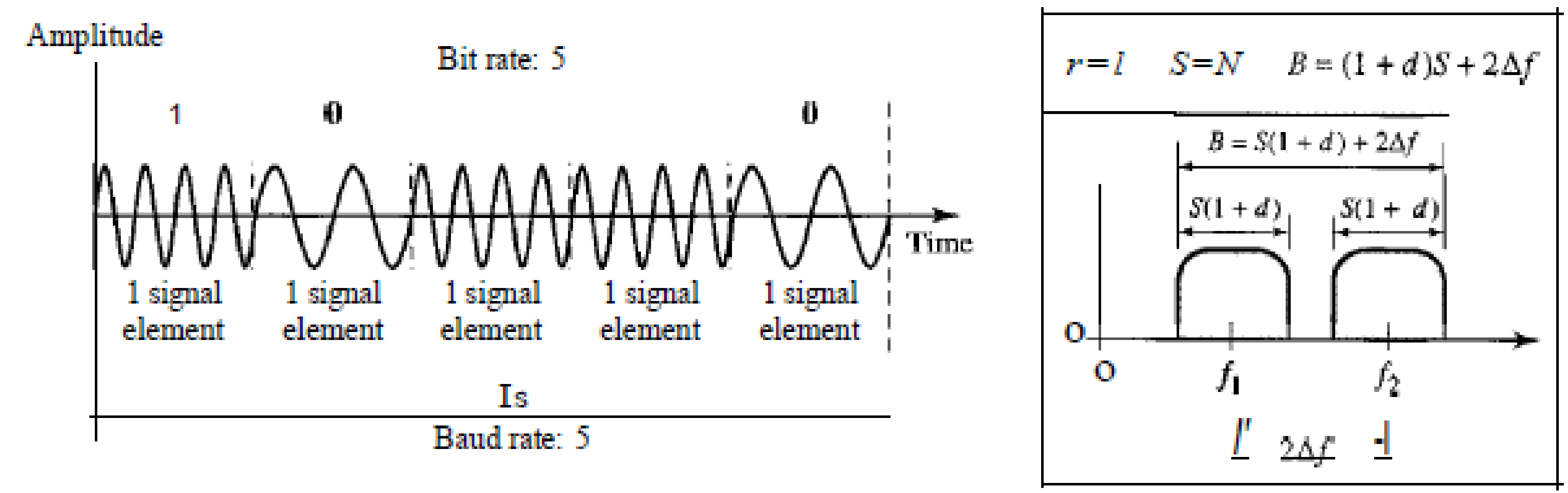


Frequency Shift Keying(FSK)

- In frequency shift keying, the frequency of the carrier signal is varied to represent data.
- The frequency of the modulated signal is constant for the duration of one signal element, but changes for the next signal element if the data element changes.
- Both peak amplitude and phase remain constant for all signal elements
- Binary FSK:
  - One way to think about binary FSK (or BFSK) is to consider two carrier frequencies.
  - In Figure 5.6, we have selected two carrier frequencies, f1 and12.
  - We use the first carrier if the data element is 0; we use the second if the data element is 1.

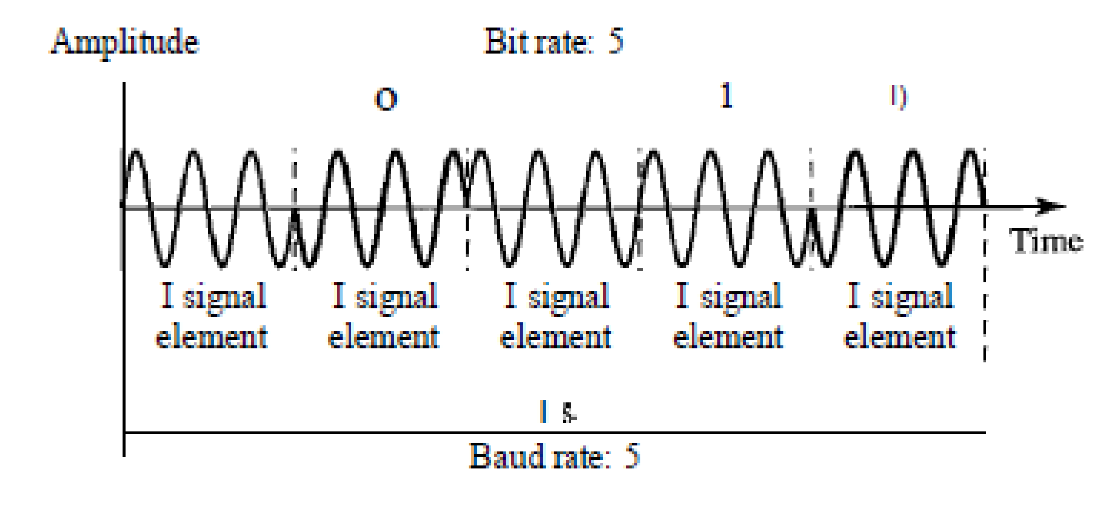
Binary FSK

Figure 5.6 *Binary frequency shift keying*



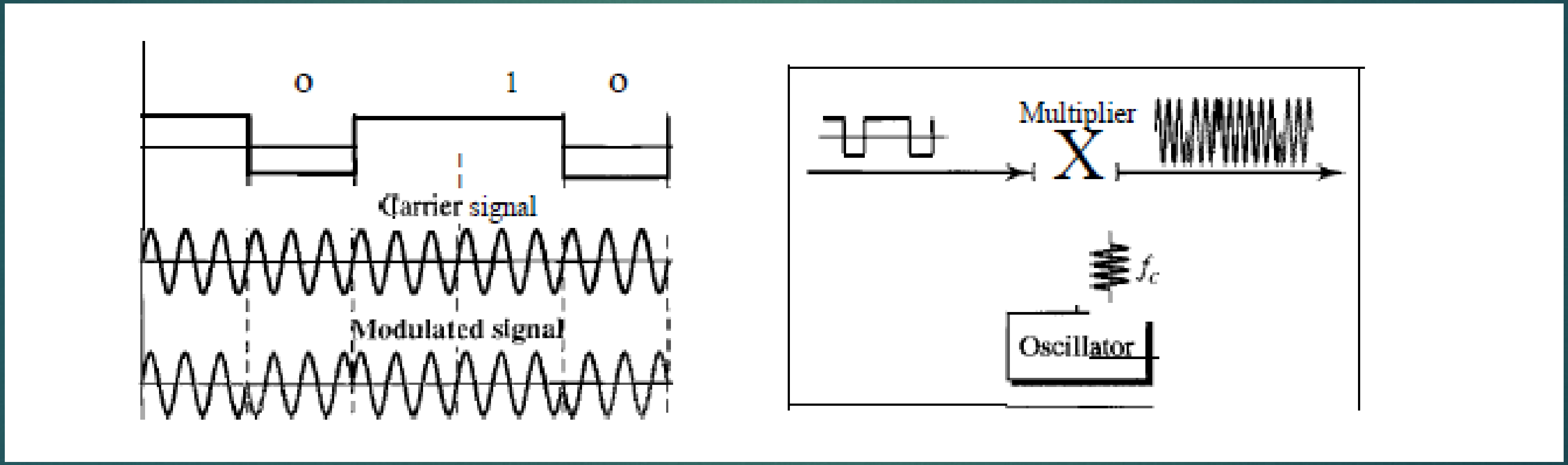
Phase Shift Keying

- In phase shift keying, the phase of the carrier is varied to represent two or more different signal elements.
- Both peak amplitude and frequency remain constant as the phase changes.
- Today, PSK is more common than ASK or FSK.
- Binary PSK:
  - The simplest PSK is binary PSK, in which we have only two signal elements, one with a phase of 0°, and the other with a phase of 180°. Figure below gives a conceptual view of PSK.



Phase Shift Keying

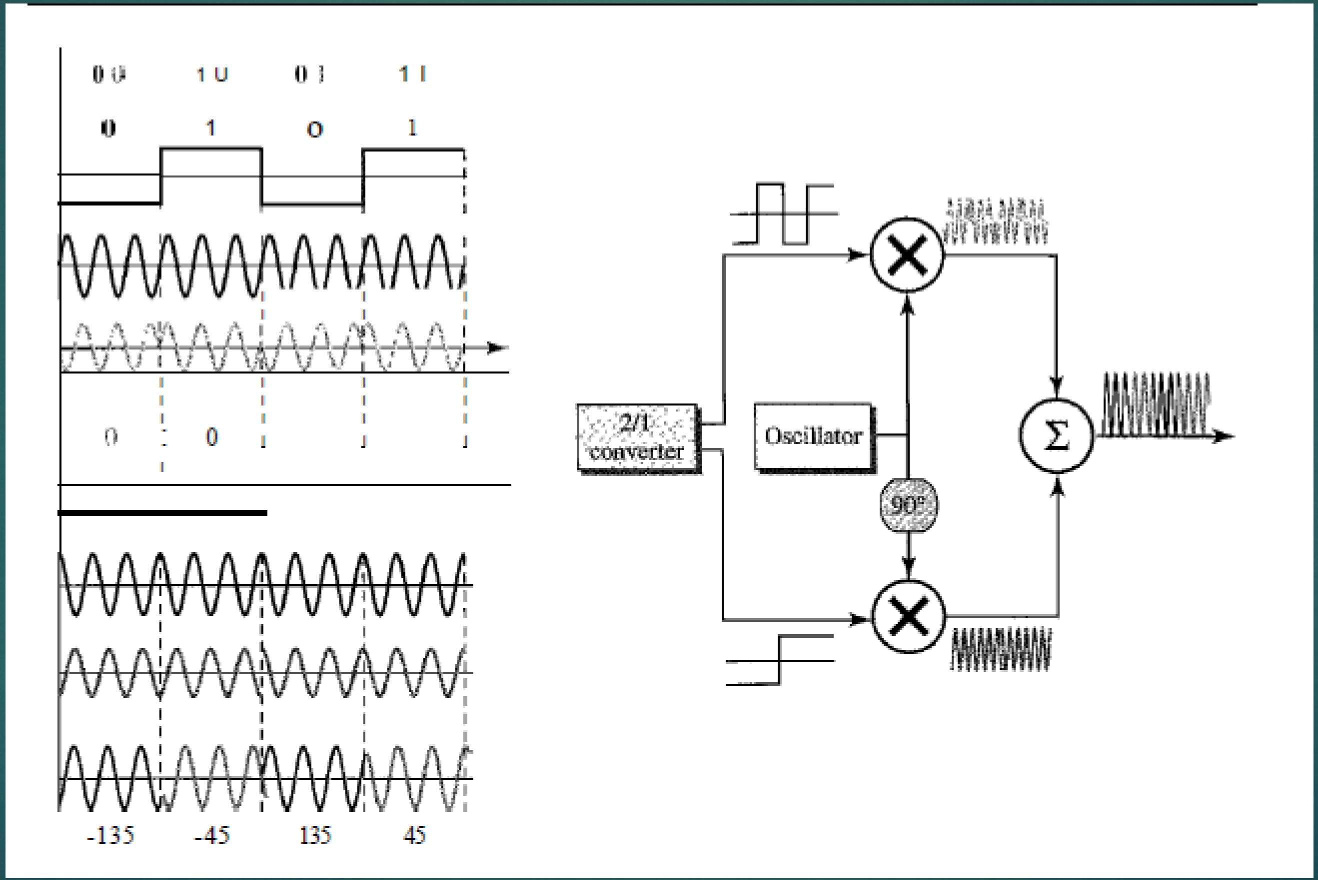
- Implementation of BPSK



Phase Shift Keying

- Quadrature PSK
  - The simplicity of BPSK enticed designers to use 2 bits at a time in each signal element, thereby decreasing the baud rate and eventually the required bandwidth.
  - The scheme is called quadrature PSK or QPSK because it uses two separate BPSK modulations.
  - The incoming bits are first passed through a serial-to-parallel conversion that sends one bit to one modulator and the next bit to the other modulator.

QPSK



Transmission Media

- The wires, cables, and other means through which data travels from its source to destination.
- Often called communication media.

Types of Transmission media

- Guided/Bounded/Wired Transmission Media
- Unguided/Unbounded/Wireless Transmission Media

Guided Transmission Media

- Twisted Pair Cable
  - STP(Shielded Twisted Pair)
  - UTP(Unshielded Twisted Pair)
- Coaxial Cable
- Fiber Optics Cable

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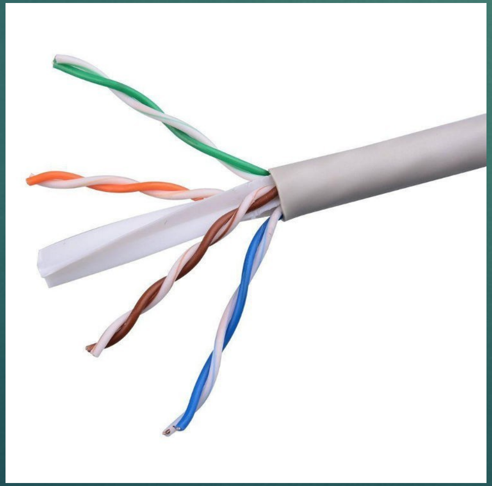
Twisted Pair Cable

- Oldest and most common transmission media
- Contains a pair of cable twisted with each other.
- Most commonly used in telephone and in LAN.
- Connected with the help of RJ-45 for LAN and RJ-11 for telephone.

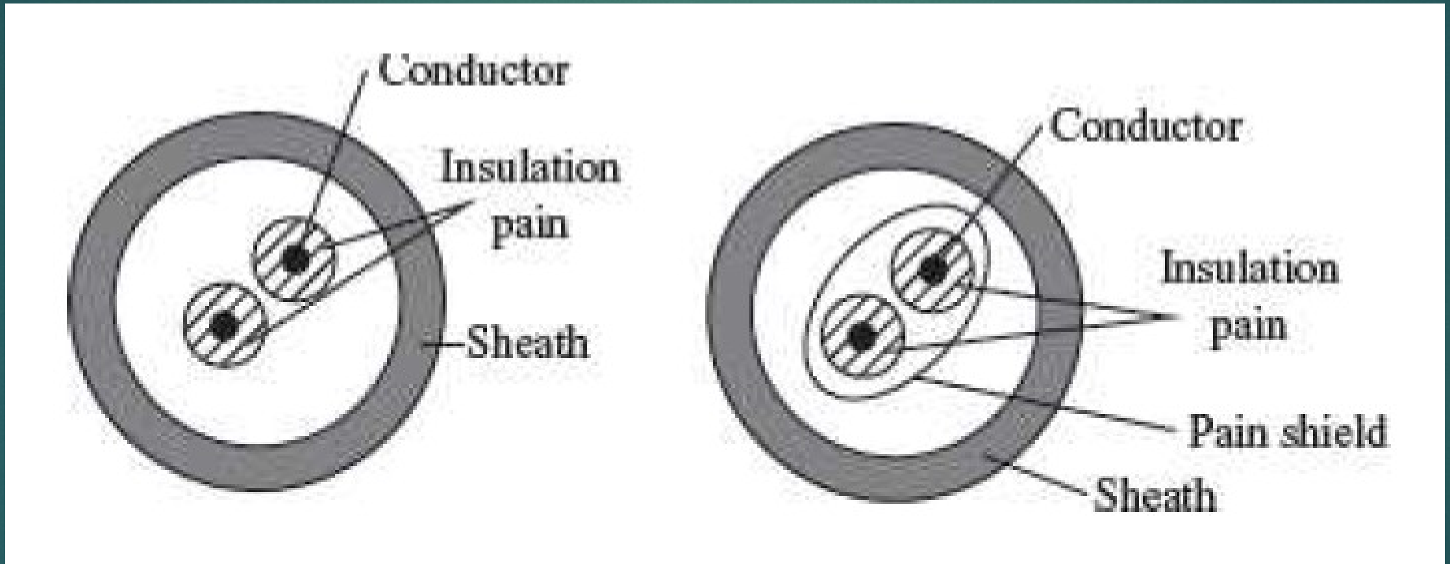


Twisted Pair Cable

RJ-45

RJ-11

Twisted Pair Cable



Advantages of Twisted Pair Cable

- Light and thin so flexible to fit
- Cheaper than other cable
- Data transmission at high bandwidth for short distance

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Disadvantages of Twisted Pair Cable

- Cannot be used for long distance transmission
- Slower rate of data transmission as compared to other cable
- Prone to noise
- Electric field and magnetic field can easily affect the transmission

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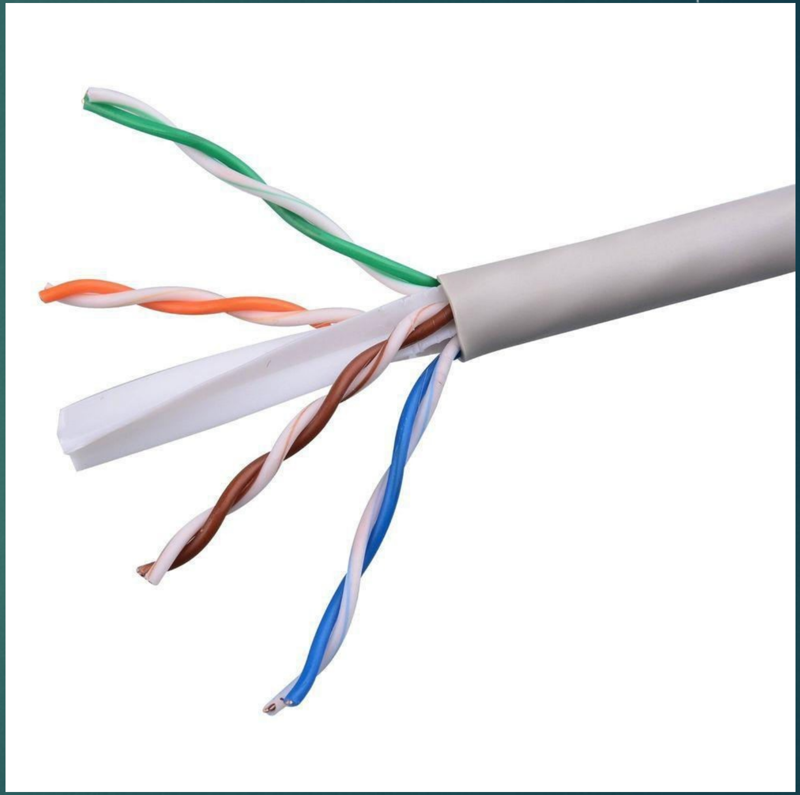
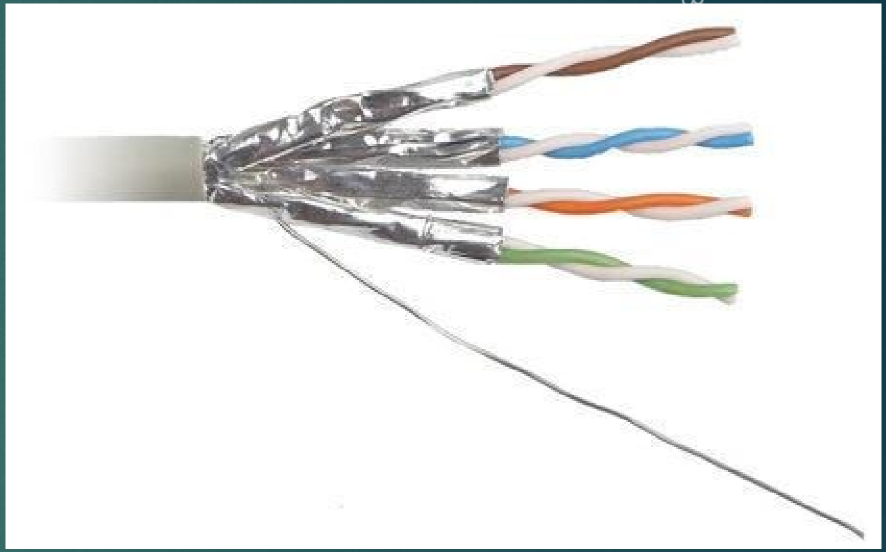
UTP(Unshielded Twisted Pair)

- Most common twisted pair
- No extra covering
- Data transmission over a short distance
- Cheaper



STP(Shielded Twisted Pair)

- Rarely used
- Extra covering with metal foil
- Data transmission over long range
- Expensive



Coaxial cable

- Carries data signal at higher frequency and faster speed
- Commonly used for transmission of signal in TV and broadband transmission.
- Transmit many signals at the same time
- Each signal is called a channel.
- Has very high bandwidth

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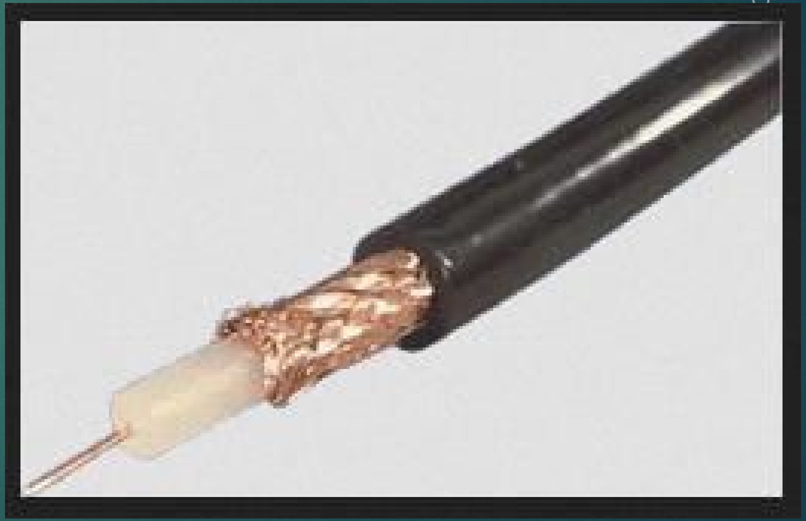
Coaxial cable

- Has a single copper conductor at its center.
- Plastic layer provides insulation between center conductor and a braided metal shield.
- Surrounded by an external insulation layer.



Coaxial cable

Advantages of Coaxial Cable

- Provides faster data transmission than twisted pair
- Data transmission over medium range.
- Easier to install , modify and manage the network

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Disadvantages of Coaxial Cable

- Expensive than twisted pair cable
- Not appropriate for long distance transmission
- Rarely used at present for a computer network.

Fiber Optics

- Made up of glass or plastic
- Transmits signal in form of light.
- Can carry voice , video and data.
- Large bandwidth and carry signal for extremely long distance.
- Immune to electromagnetic interference
- Secure than other cables.

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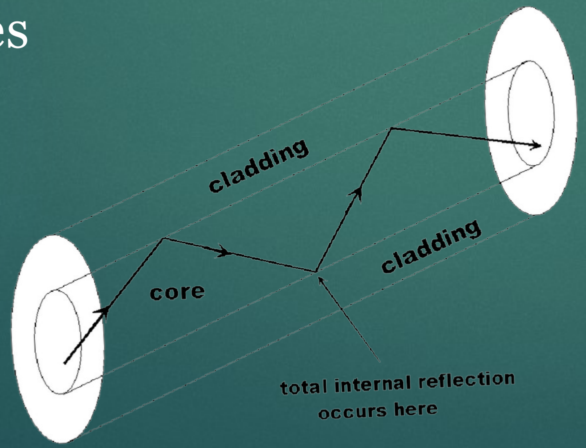
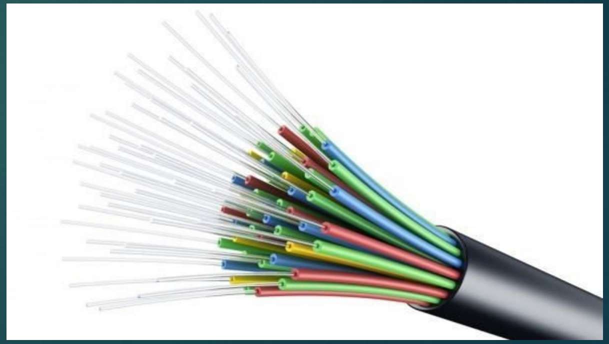
Fiber Optics

- Consist of glass core at the center
- Surrounded by several layers of protective materials.
- Cable itself is a core fiber surrounded by cladding
- LED send signal down the cable.
- A detector receives the signals & converts them back to electrical impulses





Optical fiber

Advantages of Fiber Optics

- Fastest data transmission than other transmission media.
- Can be used for both short and long distance transmission
- Error free highly secured transmission

Disadvantages of Optical Fiber

- Expensive and difficult to install
- Prone to damage
- Skilled technical manpower required to install

Unguided/Unbounded/Wireless Transmission Media

- Those transmission media that aren't bounded by wire to send data from source to destination is wireless transmission media.
- Data flow in atmosphere.

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Types of Wireless Transmission Media

- Microwave system
- Radio Transmission
- Infrared
- Satellite Communication,etc.

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Microwave System

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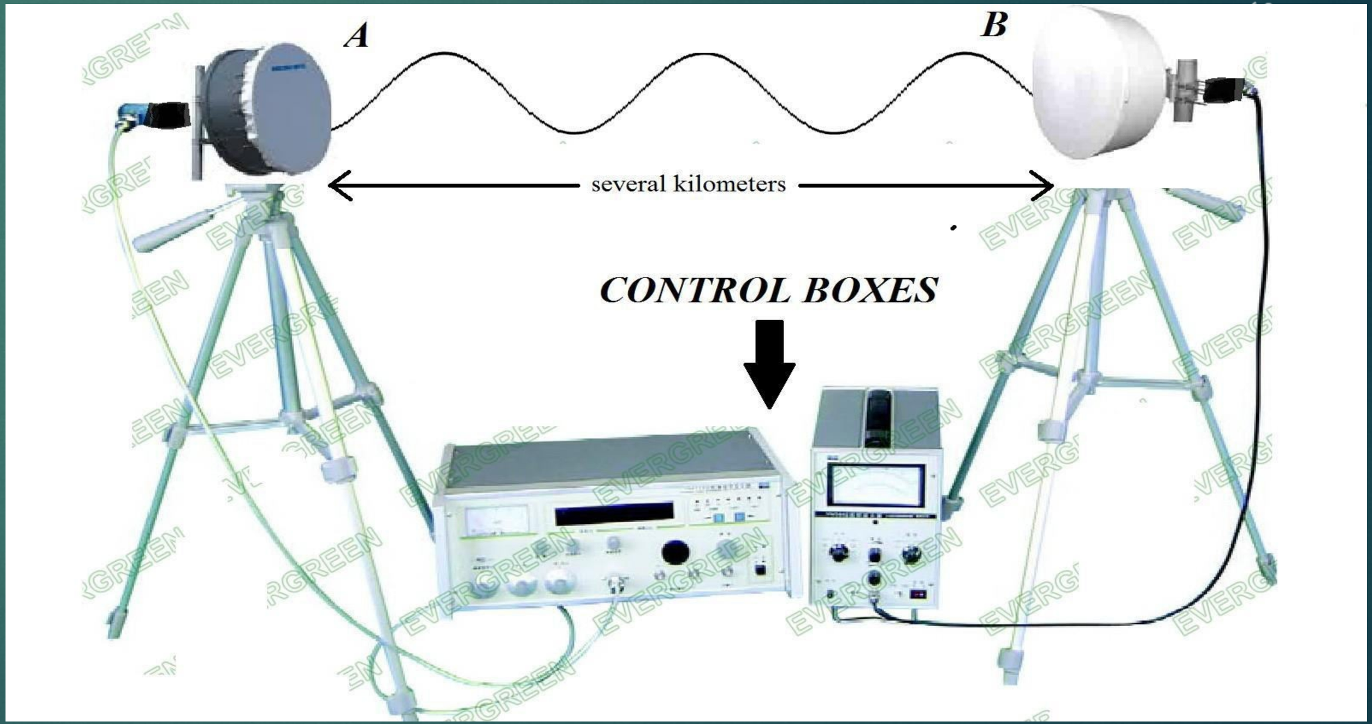
- Uses very high frequency radio signal to transmit data through the air.
- Transmitter and receiver of a microwave system should be in LOS(Line of Sight) as it can't be bend.
- Transmitting and receiving antenna must be placed on some place at considerable height(buildings , top of hills , etc.)
- Very long distance transmission isn't possible.
- In order to overcome LOS and short distance, repeater are used at intervals of 25 to 30 km apart.
- Repeater receives the signal amplifies it and send it to the next tower.

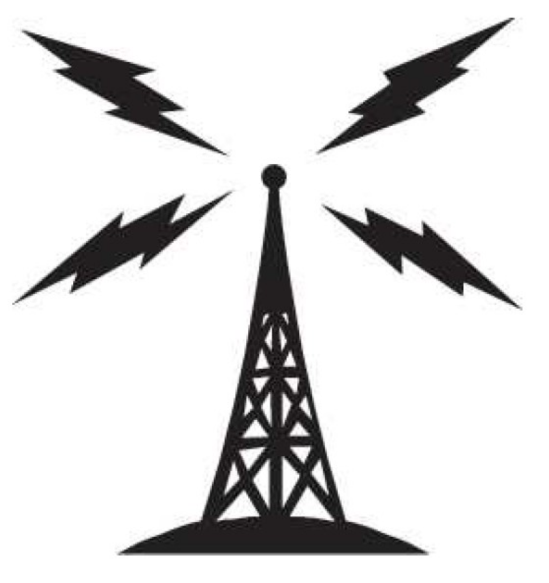
Microwave System

- Radio frequencies are used



Radio Transmission

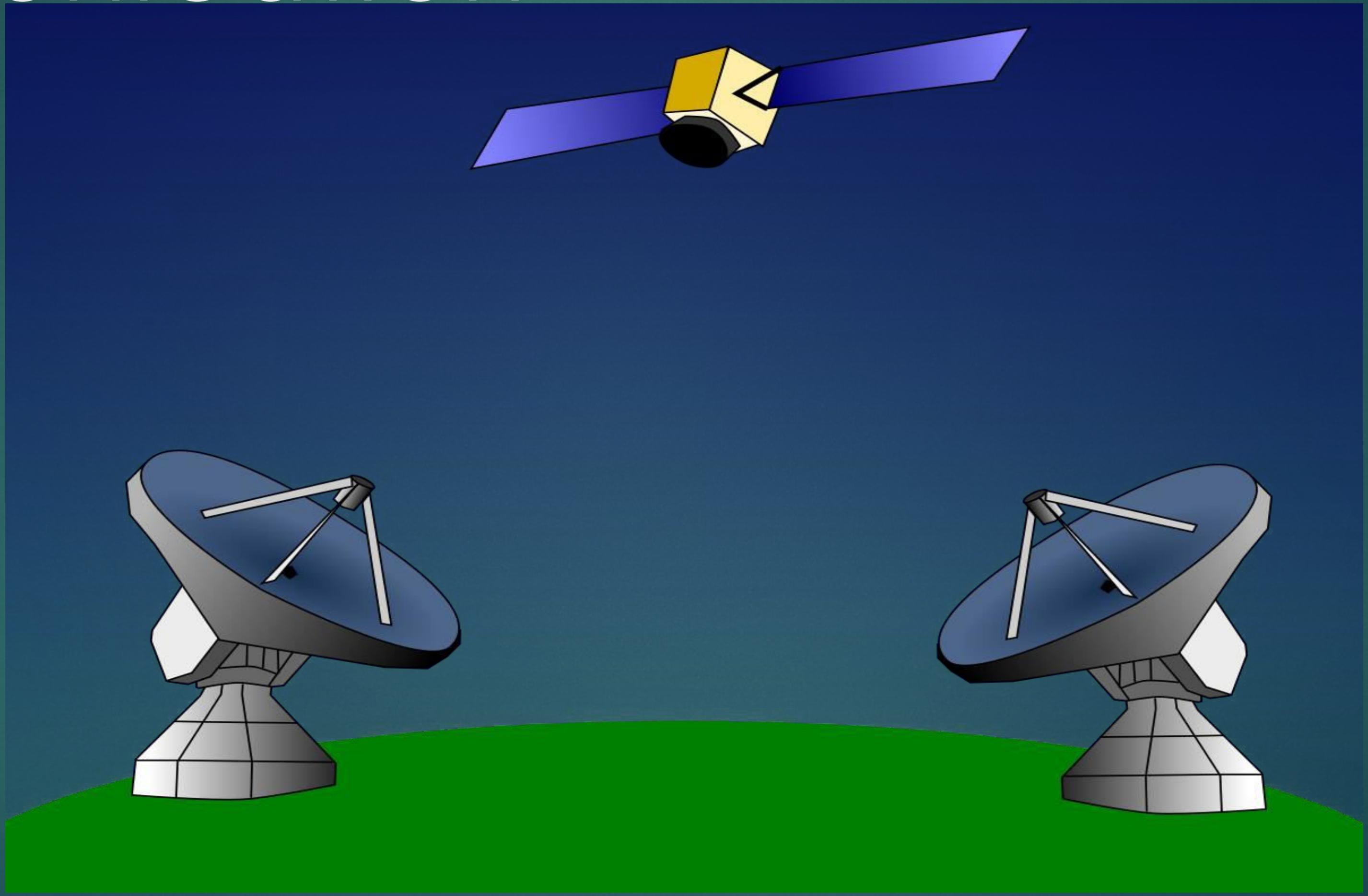
- The electromagnetic radio waves that operate at the radio frequency are also used to transmit computer data. This transmission is also known as Radio Frequency (RF) transmission.
- The computers using RF transmission do not require a direct physical connection like wires or cable.
- Each computer attaches to an antenna hat can both send and receive radio transmission.



Satellite Communication

- Most common worldwide communication system at present.
- Uses satellite as a repeater.
- Have receiver and transmitter located in ground stations.
- Microwave signal is transmitted from a transmitter on earth to the satellite at space.
- Satellite amplifies the weak signal and transmits it back to the receiver.
- In order to cover large distance multiple satellite are used.

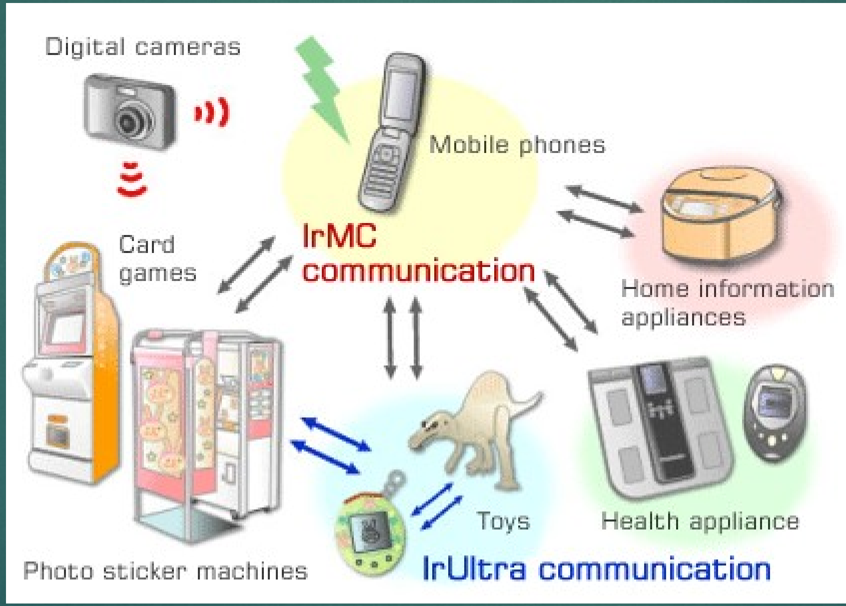
Satellite communication



Infrared

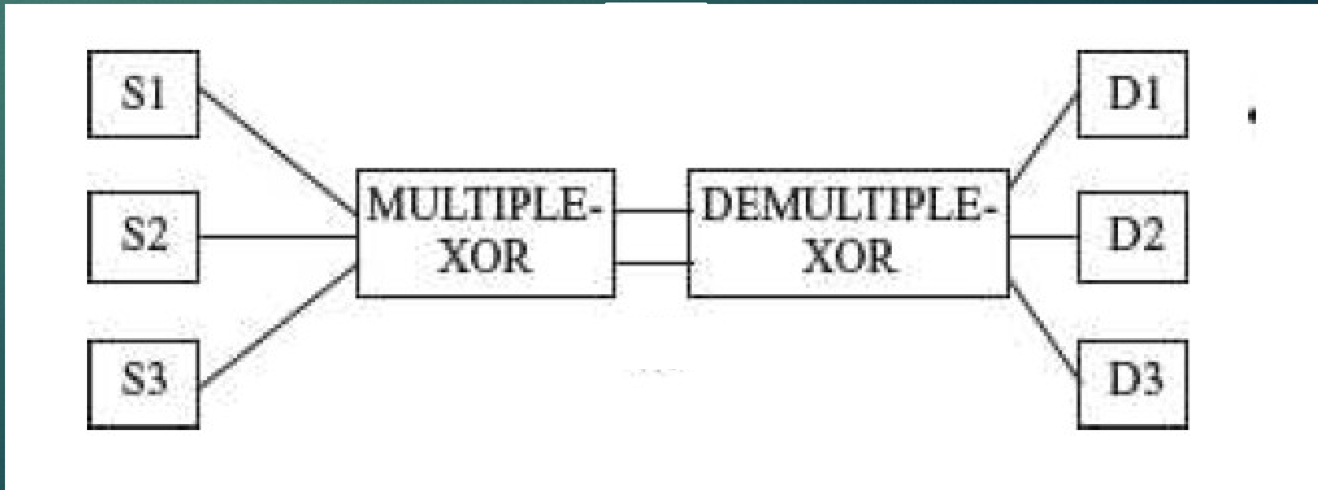
- Used for short range communication
- LOS is necessary
- High frequency signal
- Cannot penetrate walls. So prevents interference between systems.
- Mainly used in wireless mouse , remote control , etc
- Generally not used outside as sun's infrared can interfere.

Infrared


Digital cameras
Mobile phones
IrMC communication
Card games
Home information appliances
Photo sticker machines
Toys
Health appliance
IrUltra communication

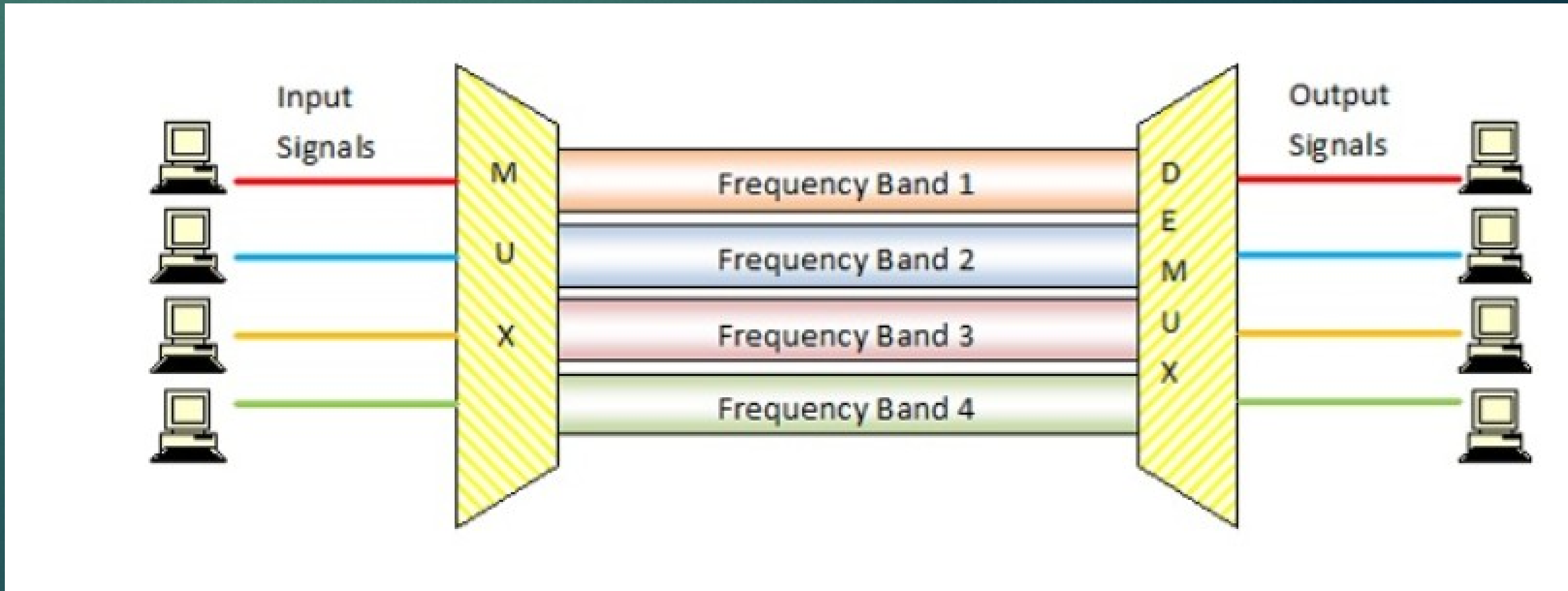
Multiplexing

- Transmission medium have varying data carrying capacities.
- To utilize the full capacity of the transmission medium, computer networks use separate channels that allow sharing of a single physical connection for multiple communication.
- Multiple carrier signals are transmitted over the same medium at the same time and without interference from each other.
- The combining of multiple signals into a form that can be transmitted over a single link of a communication medium is called multiplexing.
- The three basic multiplexing techniques are
  - Frequency Division Multiplexing (FDM)
  - Time Division Multiplexing(TDM)
  - Wavelength Division Multiplexing (WDM).



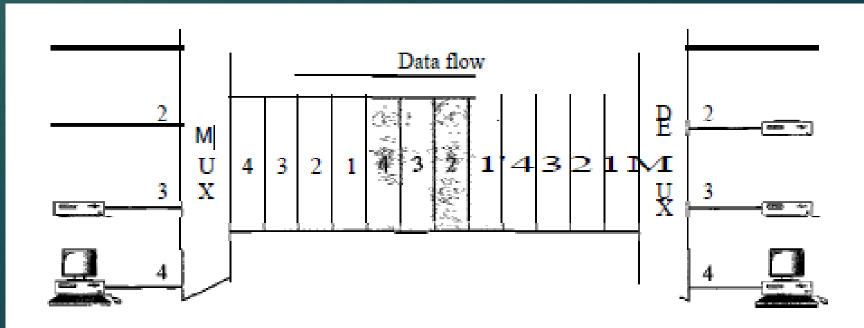
FDM(Frequency Division Multiplexing)

- Frequency division multiplexing (FDM) is a technique of multiplexing which means combining more than one signal over a shared medium.
- In FDM, the total bandwidth is divided to a set of frequency bands that do not overlap.
- The frequency bands are separated from one another by strips of unused frequencies called the guard bands, to prevent overlapping of signals
- FDM combines different carrier frequencies signals into a single signal of higher bandwidth. The bandwidth of the communication medium link carrying the combined signal is greater than the sum of the bandwidth of the individual signals that are combined.



TDM(Time Division Multiplexing)

- Each connection occupies a portion of time in the link.
- This happens when the data transmission rate of media is greater than that of the source, and each signal is allotted a definite amount of time.
- These slots are so small that all transmissions appear to be parallel.
- In frequency division multiplexing all the signals operate at the same time with different frequencies, but in time-division multiplexing, all the signals operate with the same frequency at different times.
- It is of two types:
- Synchronous TDM
  - The time slots are pre-assigned and fixed. This slot is even given if the source is not ready with data at this time.
  - In this case, the slot is transmitted empty. It is used for multiplexing digitized voice streams.



TDM

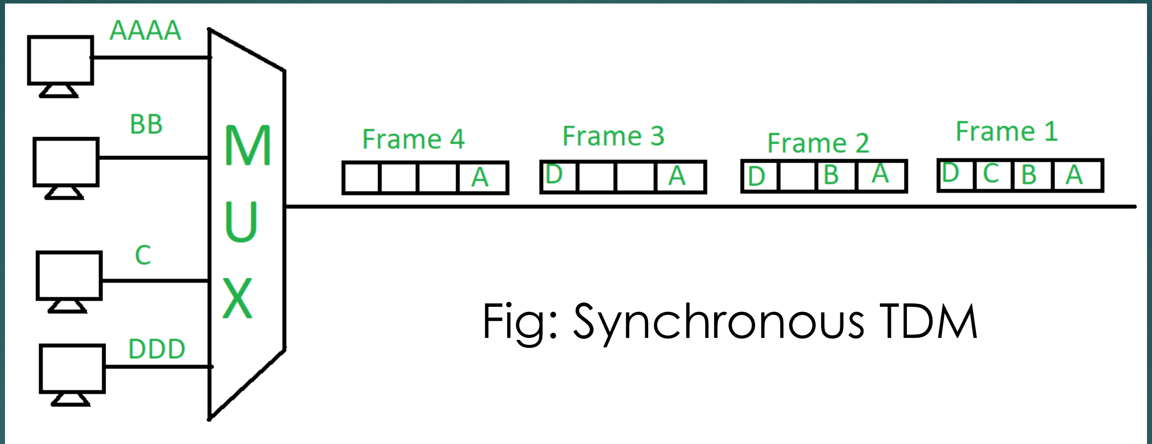
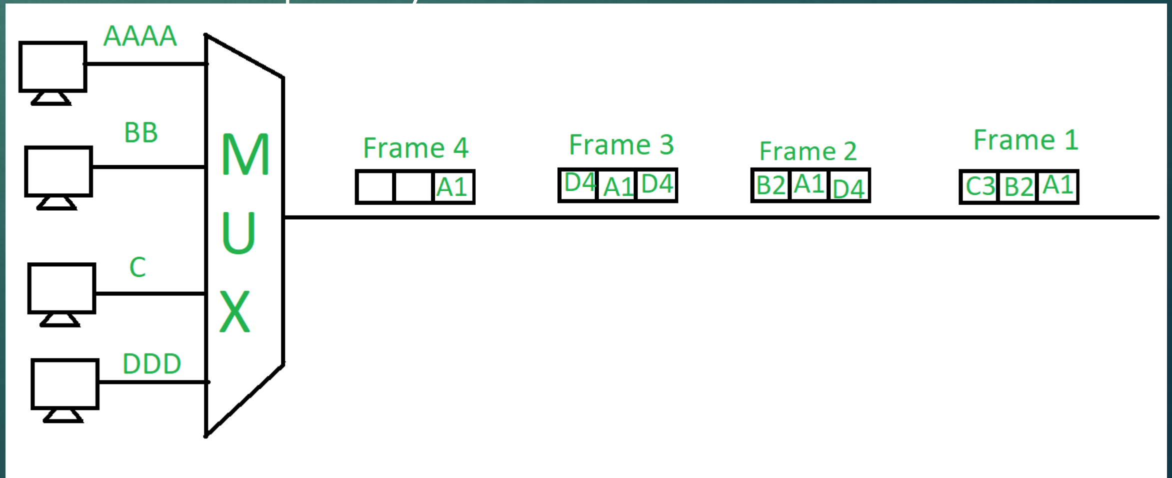


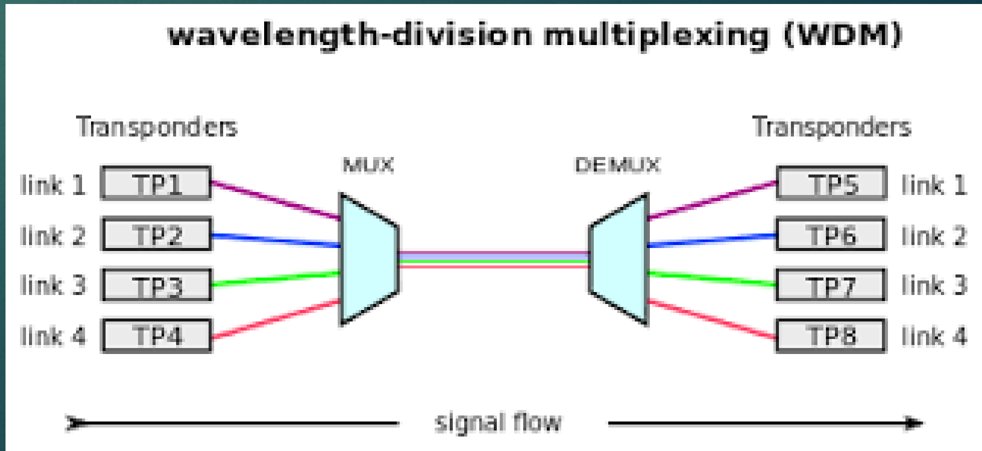
Fig: Synchronous TDM

- Asynchronous TDM
  - The slots are allocated dynamically depending on the speed of the source or their ready state.
  - It dynamically allocates the time slots according to different input channels' needs, thus saving the channel capacity.



WDM(Wavelength Division Multiplexing

- WDM is similar to FDM except that FDM involves electromagnetic spectrum below light and WDM involves light signals.
- WDM uses very high frequencies
- Wavelength division multiplexing (WDM) is a technique of multiplexing multiple optical carrier signals through a single optical fiber channel by varying the wavelengths of laser lights.
- The optical signals from different sources or (transponders) are combined by a multiplexer, which is essentially an optical combiner. They are combined so that their wavelengths are different.
- The combined signal is transmitted via a single optical fiber strand.
- At the receiving end, a demultiplexer splits the incoming beam into its components and each of the beams is send to the corresponding receivers.



Switching

1858

- Aim of Data Communication and Networking is to facilitate the exchange of data such as audio, text or video between various points in the world.
- This transfer of data takes place over the computer network over which the data travels smoothly.
- For the delivery of data or information with the ease of accuracy various types of Switching Techniques are employed in the Data Communication and Networking

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Types of Switching

- Circuit Switching
- Packet Switching
- Message Switching

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Circuit Switching

- Circuit Switching is generally used in the public networks.
- It come into existence for handling voice traffic in addition to digital data
- Here the network connection allows the electrical current and the associated voice with it to flow in between the two respective users.
- The end to end communication was established during the duration of call.
- Here the routing decision is made when the path is set up across the given network.
- After the link has been sets in between the sender and the receiver then the information is forwarded continuously over the provided link.

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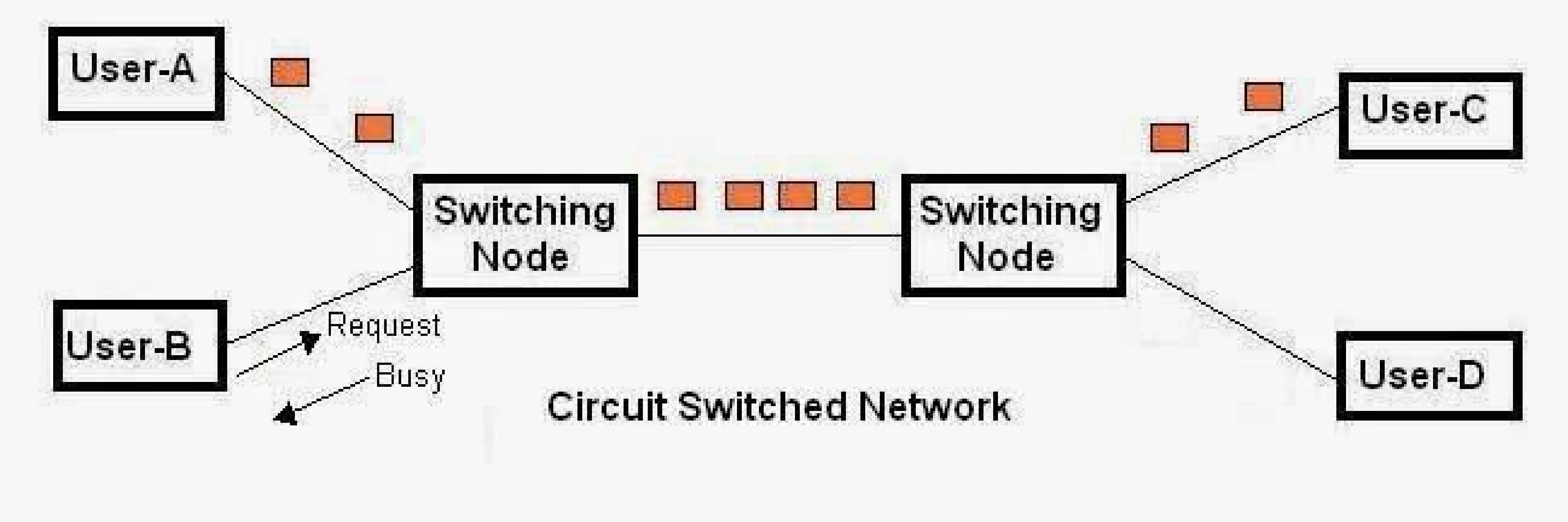
Circuit Switching



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Advantages of Circuit Switching

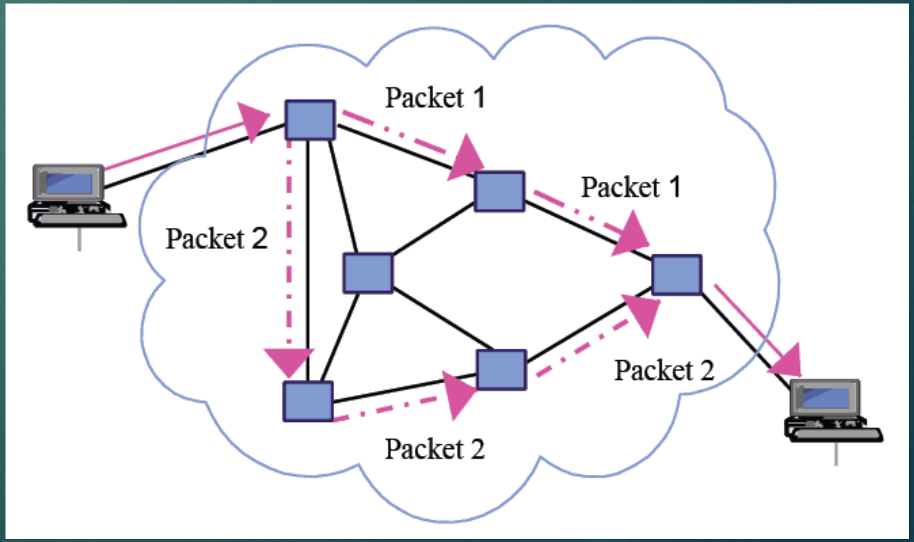
- It uses a fixed bandwidth.
- A dedicated communication channel increases the quality of communication.
- Data is transmitted with a fixed data rate.
- No waiting time at switches.
- Suitable for long continuous communication.

Disadvantages of Circuit Switching

- A dedicated connection makes it impossible to transmit other data even if the channel is free.
- Resources are not utilized fully.
- The time required to establish the physical link between the two stations is too long.
- As a dedicated path has to be established for each connection, circuit switching is more expensive.
- Even if there is no transfer of data, the link is still maintained until it is terminated by users. By this channel remains ideal for a long time thereby making circuit switching inefficient.
- Dedicated channels require more bandwidth.

Packet Switching

- In Packet Switching, messages are broken up into packets
- Each of which includes a header with source, destination and intermediate node address information.
- Individual Packets in packet switching technique take different routes to reach their respective destination



Advantages of Packet Switching

- Delay in delivery of packets is less, since packets are sent as soon as they are available.
- Switching devices don't require massive storage, since they don't have to store the entire messages before forwarding them to the next node.
- Data delivery can continue even if some parts of the network faces link failure. Packets can be routed via other paths.
- It allows simultaneous usage of the same channel by multiple users.
- It ensures better bandwidth usage as a number of packets from multiple sources can be transferred via the same link.

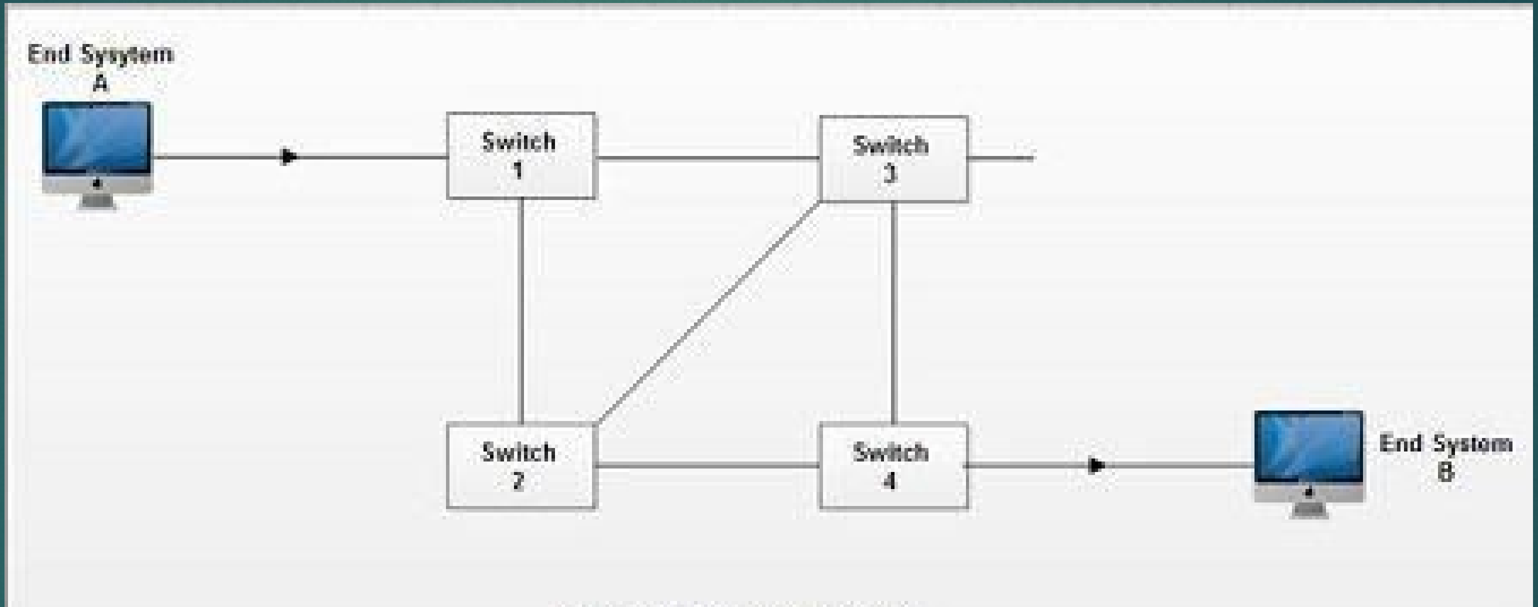
Disadvantages of Packet Switching

- They are unsuitable for applications that cannot afford delays in communication like high quality voice calls.
- Packet switching high installation costs.
- They require complex protocols for delivery.
- Network problems may introduce errors in packets, delay in delivery of packets or loss of packets. If not properly handled, this may lead to loss of critical information.

Message Switching

- In Message Switching it is not necessary to established a dedicated path in between any two communication devices.
- Each message is treated as an independent unit and includes its own destination source address by its own.
- Each complete message is then transmitted from one device to another through internet work.
- Each intermediate device receive the message and store it until the nest device is ready to receive it and then this message is forwarded to the next device.
- For this reason a message switching network is sometimes called as Store and Forward Switching.

Message Switching



Message Switched data Network